Sky and TELESCOPE

In This Issue:

Three Riddles of Plato

Some Astronomical Applications of Image Converters

Lick Observatory 120-inch Album

The Meaning of Betelgeuse

Stars for April

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Vol. XIV, No. 6

APRIL, 1955

40 cents

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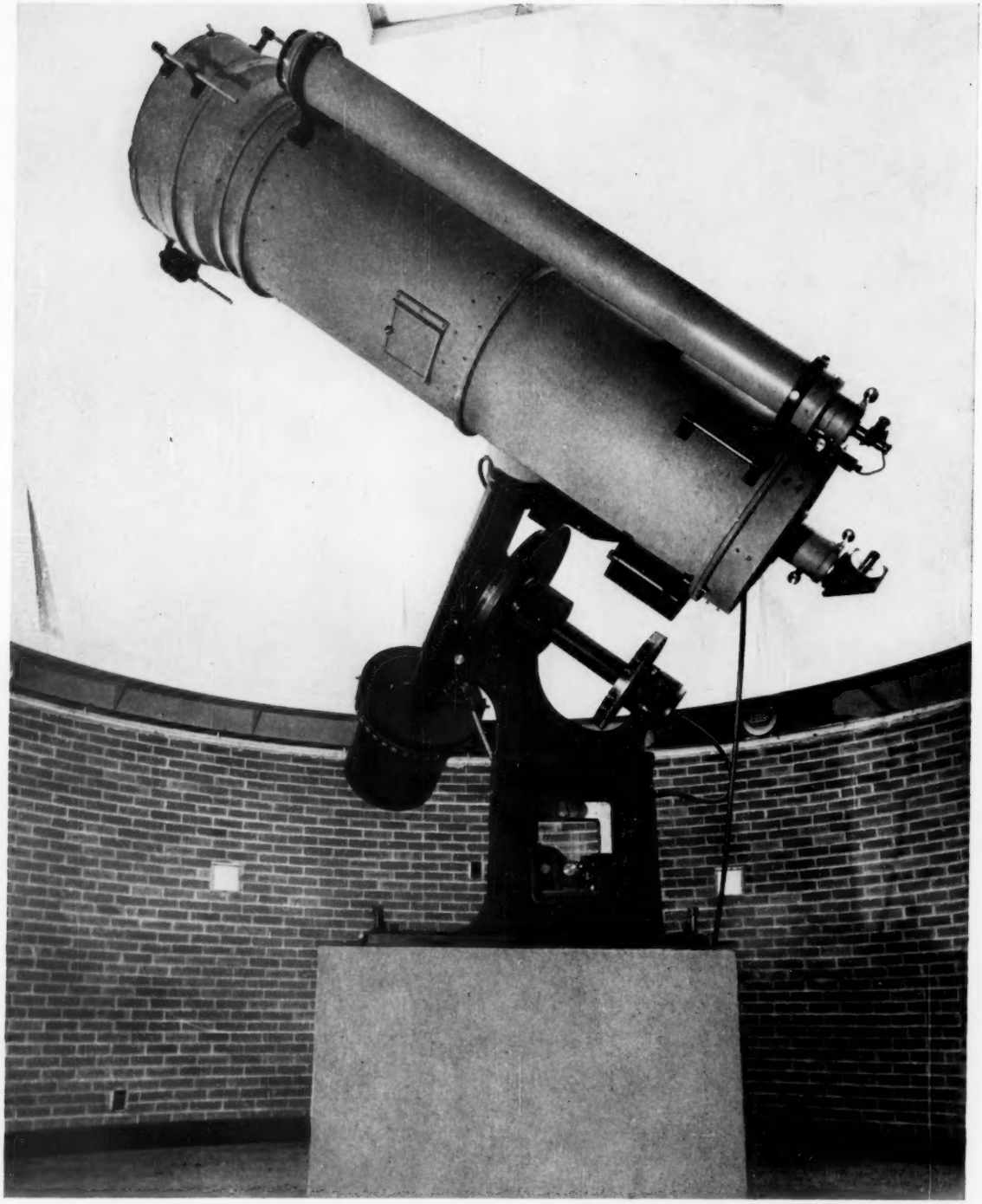
A lunar observer and his telescope



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Sky and TELESCOPE

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Vol. XIV, No. 6 APRIL, 1955

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COVER: Jackson T. Carle, of Fresno, Calif., adjusts the driving mechanism of his 8-inch telescope, constructed by him and William Schaefer, of Inglewood, Calif. Mr. Carle made the mirror; its 90-inch focal length is excellent for lunar and planetary observing, and double stars can be split to or below 0.6 second of arc. The tube is in two sections, and the mounting may be taken apart for automobile transportation; assembly requires 10 minutes. The drive mechanism will operate from 110-volt alternating current or from a 6-volt auto battery using an inverter. The entire telescope cost less than $100 in cash — plus several hundred hours of work. (See page 221.)

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Notes on the Eclipse

SOUTHEAST ASIA, from Ceylon through Siam to the Philippines, will be traversed by the moon's shadow during the total eclipse of the sun on June 20, 1955. The exceptional length of totality, over seven minutes at some places, has attracted much attention by astronomers, and a number of expeditions are being planned.

Many observers have decided upon Ceylon as the most favorable region from which to observe. The central line of the path of totality cuts across the island, entering it near Lunuwila on the west coast, and leaving it between Trincomalee and Batticaloa on the east. Ceylon, like the Philippines, will be having its southwest monsoon season at eclipse date. However, conditions should be excellent in eastern Ceylon, which is sheltered from the monsoon by the mountains that divide the island from north to south. The probability that bright sunshine may be expected there at the time of the eclipse is about 75 to 80 per cent.

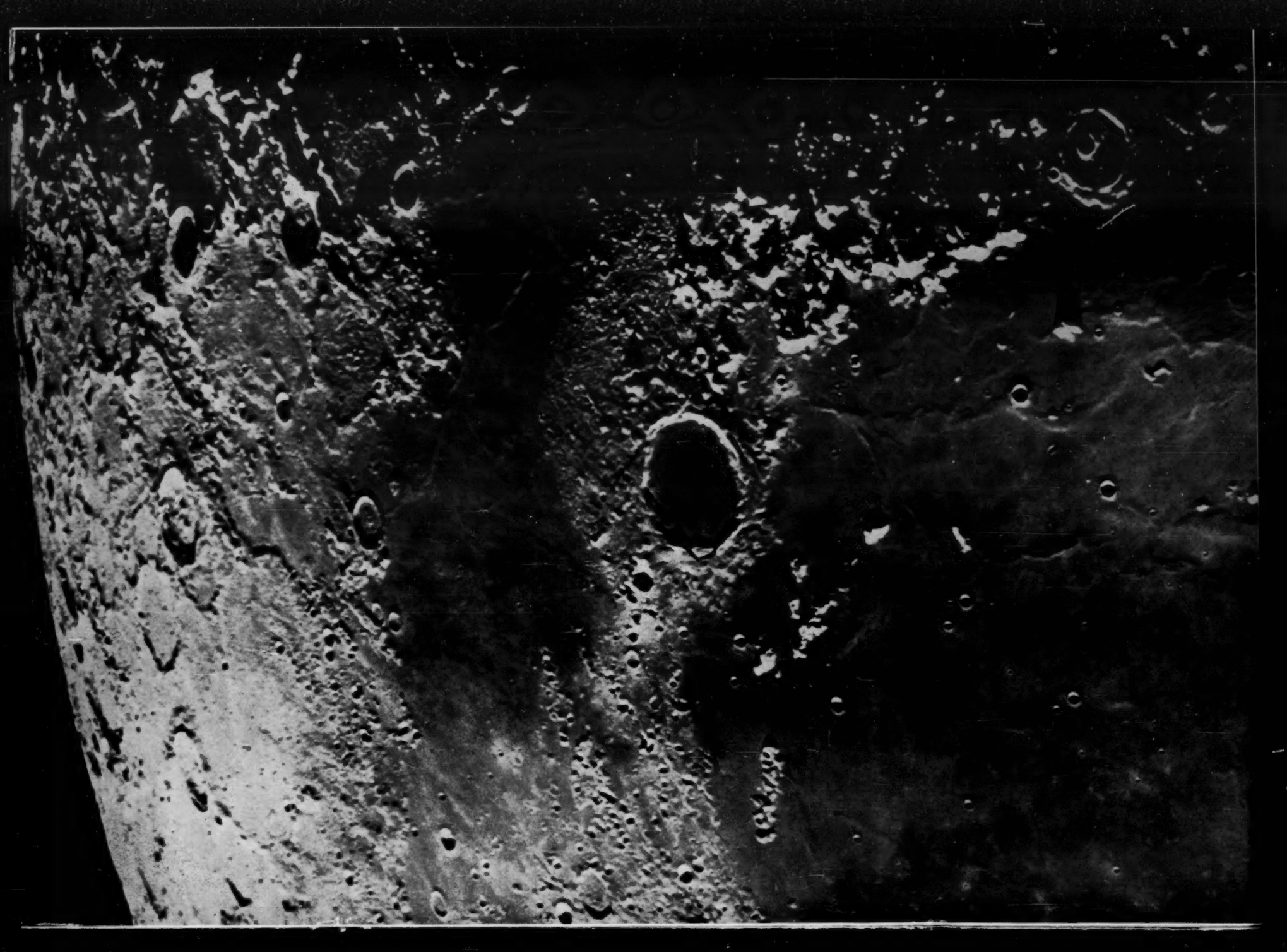
Tentative plans have been reported for several expeditions to Ceylon. One party of British astronomers will include Drs. R. O. Redman and H. von Klueber of Cambridge, and others from London and St. Andrews, Scotland. A nearby station will be manned by German observers from the Potsdam Observatory, together with Dr. A. Dollfus, Meudon Observatory.

Dr. A. G. Wilson, Lowell Observatory, intends to measure the variation in the ozone of the earth's atmosphere during the eclipse. Other parties from India, Holland, Switzerland, and Japan will be going to Ceylon.

While ground observers in Ceylon are much less apt to be clouded out, observations from aircraft are being planned for the Philippines, where the eclipse will occur near local noon, instead of shortly after 8 a.m. as in Ceylon. Detailed information about Philippine weather appeared on page 142 of the February issue. Dr. C. del Rosario, director of the Manila Weather Bureau, has kindly sent the following information:

The altitude which an aircraft would have to attain to avoid any interference from clouds depends mainly on the presence of two principal meteorological phenomena—the intertropical convergence zone and tropical cyclones. During the month of June the mean position of the intertropical convergence zone lies across Mindanao and Palawan, oriented WNW-ESE. It is not possible to predict its exact location during the eclipse. However, if it strays north of its normal position, which is possible, then we may expect buildups extending well over 30,000 feet.

In the month of June, an average of three typhoons cross the country or adjacent areas. The presence of a typhoon in the vicinity would render observations from aircraft hazardous. The probability of the Manila aerodrome closing down due to bad weather conditions is relatively nil.



Three Riddles of Plato

JACKSON T. CARLE

DURING the past century Plato, "the Great Black Lake," nestling at the northeast tip of the lunar Alps near the edge of Mare Imbrium, probably has been the most intensively observed feature on the moon. And many who have studied this great walled plain are reluctant to accept the general belief that the moon is a dead world where nothing ever happens. For it appears that subtle details on Plato's dark floor undergo changes which many experienced selenographers say cannot be explained by the varying illumination and libration.

The purpose of this article is to suggest to other amateurs intensive observation of the Great Black Lake as a fascinating and useful lunar study, and to share with them my satisfaction in seeing with modest equipment shadings, spots, and craterlets not shown on photographs by even the world's largest telescopes.

As the facing picture shows, you scarcely can miss Plato, for this crater is one of the darkest areas on the moon, lying well toward the north pole. Plato presents an egg-shaped outline, which alters with differing libration. Allowing for foreshortening, it is probably approximately circular. On a moon chart the lines of 10° east longitude and 50° north latitude intersect in the southeastern part of the crater floor.

Plato is about 60 miles in diameter, with rim walls rising from 3,000 to 5,000 feet above the floor, and peaks up to 7,400 feet high.

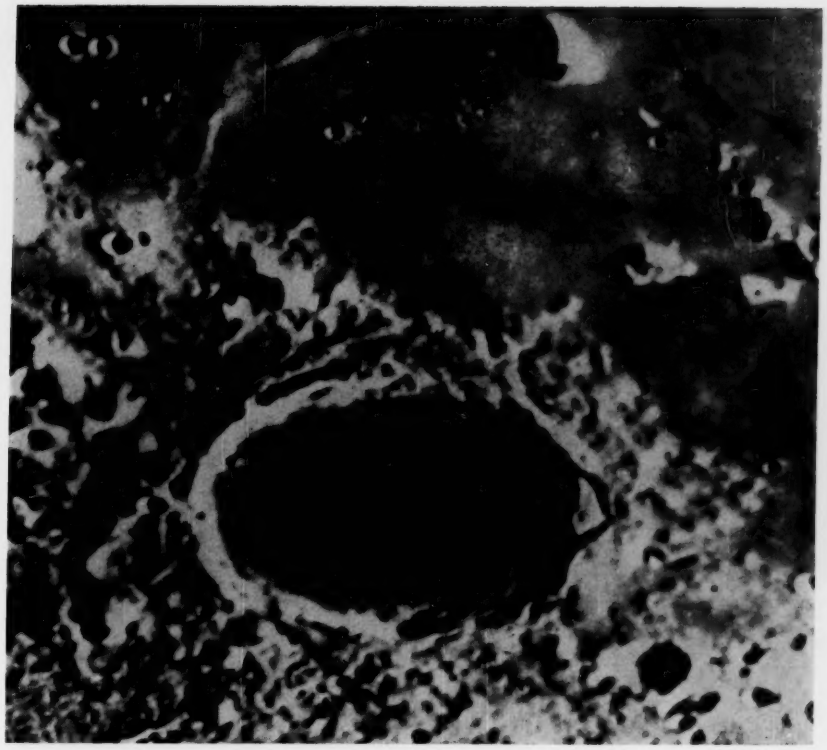
If you first look at the Great Black Lake as the sun is rising there—about a day and a half after first quarter—you will be struck by the extraordinary ruggedness of the west rim as revealed by its shadow cast upon the floor. With the sun low on the horizon viewed from Plato, even minor elevations cast long shadows, giving an exaggerated idea of the heights of the summits on the rim.

From our telescopic vantage point we see the shadow of the western ramparts extending completely across the 60-mile floor in jagged outline, and most of the interior of the crater is hidden in velvety blackness which knows no morning twilight. Even as we watch, the shadows recede across the floor with surprising speed. Within an hour the eastern half of the plain lies revealed in sunlight except for one needle-like black shadow still extending completely across Plato. Watch this shadow carefully as it quickly draws westward before the rising sun. Does its outline change? Does it grow broader or narrower? Does the shadow at any time present a hooked tip?

This shadow is cast by a solid, immovable mountain, and can change only from the increasing elevation of the sun and the nature of the surface across which the shadow falls. Herein lies one of the three riddles of Plato we shall discuss.

The testimony as to the conformation of the crater floor is surprisingly contradictory. In 1892-93 William H. Pickering studied Plato carefully at Harvard Observatory's station at Arequipa, Peru. His results, published in Vol. 32 of the Harvard *Annals*, report the floor of Plato as "extremely convex," much more so than the regular spherical curve of the moon. He also remarks upon irregularities and slopes in the floor.

The Mount Wilson picture on this page is one of the best photographs ever taken of Plato. In addition to five interior craterlets, the variegated pattern of light and dark splotches may be seen. The wedge-shaped light area at the upper right of the floor is the "sector." Under magnification, the original negative shows a series of parallel light and dark areas running from the upper rim across the floor. These look like rolling ridges with intervening hollows, extending from the south rim northward to the central part of the interior. On a number of occa-



An enlargement of a small section of a 100-inch photograph of the moon, showing five craterlets with interior shadows, including one just within the dark shadow on the lower right edge of the crater floor. Near the top of the field is the mountain mass Pico, and at the upper left the two pairs of craters used by the author as a test for seeing conditions. Mount Wilson and Palomar Observatories photograph.

FACING PICTURE: The lunar crater Plato dominates this area of the moon's surface. Above it is part of Mare Imbrium, containing two isolated peaks, Pico (above Plato) and Piton (in the upper left). The lunar Alps extend from the upper left down to Plato; Mt. Blanc, 14,000 feet high, is here situated 2¼ inches from the left edge and 3½ inches from the top. Mare Frigoris stretches below (to the north of) Plato, and the mountains and craters of the moon's north polar regions are seen greatly foreshortened. As in most telescopic views of the moon, south is at the top, and east at the right. In this case, Plato is illuminated by the rays of the setting sun, although the sun is toward the east in the sky as we see it. Lick Observatory photograph.

sions, I have seen a similar appearance, and so have other amateurs, among them David P. Barcroft and T. E. Howe. The latter's map of Plato, in the February, 1952, issue of *The Strolling Astronomer*, shows a ridge in the floor just south of the center. The ridge is one of two floor features mentioned in Barcroft's comments.

Twice I have noted dark oval patches soon after sunrise, which quickly disappeared; at other times, with similar illumination, no patches were seen.

On April 3, 1952, H. P. Wilkins and Patrick A. Moore observed Plato with the 33-inch Meudon refractor. The former reported that "the floor or plateau appeared remarkably uniform and level," but he does show some details in the accompanying drawing made that night. Similarly, in his book, *A Guide to the Moon*, Moore describes Plato from his view that night as "probably the most level spot on the Moon."

In Dr. Wilkins' drawing the shadow of the west wall extends about a fifth of the way across the floor. The long shadow of the southerly peak juts farther east, and is hooked to the south. Does this shadow appear hooked because of some strange conformation of the rim, or from falling upon an uneven surface? I have looked unsuccessfully for this hook at a number of sunrises, but this failure may mean that the appearance requires certain combinations of libration and sun direction. Is Plato's interior level, convex, rolling, or irregular? Or perhaps, does it change? I don't know.

With good seeing, we may glimpse some of the tiny and difficult craterlets strewn over the darkish floor. In the apparently changing visibility and relative sizes of these elusive features over a period of years lies a second riddle posed by the Great Black Lake.

Since an intensive study of Plato was first organized by the British selenographer W. R. Birt and his co-workers in 1869, some 80 craterlets and spots have been charted. These have never all been seen by one observer or within a limited period of time. Some spots, having been seen easily, apparently disappeared—only to reappear years later and be reported as new discoveries.

The minute markings, according to E. Neison's *The Moon* (1876), include 10 craterlets, six doubtful craterlets, and 20 spots not represented as craterlets. T. G. Elger's authoritative *The Moon* (1895) states that there are 40 or more spots. "They are extremely delicate objects, which vary in visibility in a way that is clearly independent of libration or solar altitude."

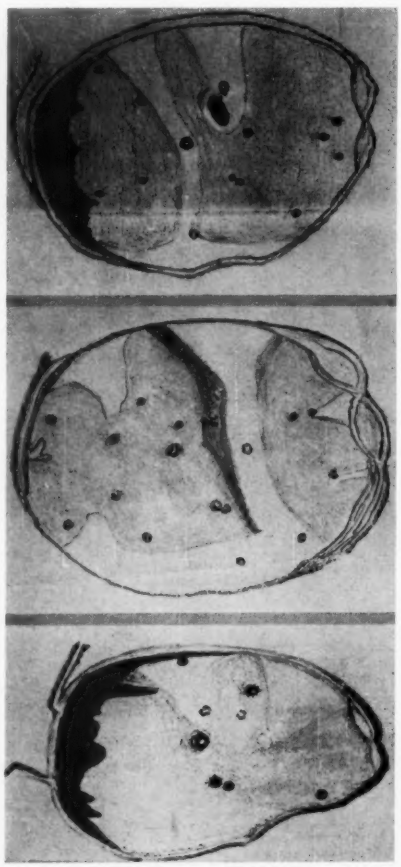
Pickering mapped 71 craterlets and spots discovered by him and earlier observers, but was never able to see more than 39. He commented that large craterlets sometimes disappear.

An interesting comparison was made by T. L. MacDonald of three charts of Plato's spots, two by Dr. Wilkins for 1936-39 and 1941-42, and an independent map by Walter H. Haas for 1935-40. In the July, 1943, *Journal* of the British Astronomical Association, MacDonald noted that the contemporary Wilkins and Haas charts were definitely comparable, but the later Wilkins map differed from both. His cautious conclusion was, "To that extent there is quite definitely a case for variations."

In 1950, Dr. Wilkins was still undecided about the riddle of the vanishing craterlets, stating that the variations observed could be due to libration and poor seeing, but that the possibility of real changes warranted further observations.

The latest but certainly not the last word comes from Moore in his book, "The evidence is conclusive and we are bound to accept a certain amount of activity on the floor of Plato."

Perhaps, after you have glimpsed Plato's craterlets and seen them steady and clear on a rare night of fine seeing, you will want to agree with Pickering that this part of the moon's surface is undergoing volcanic activity. Or perhaps you will feel that the changes are illusory. Your interest will certainly be aroused as was mine, when on one fine night I could observe 18 of the spots.



Three drawings of the lunar feature, Plato, by Jackson T. Carle, with an 8-inch reflector of 90 inches focal length. Top to bottom: February 4, 1952, 180 power; March 7, 1952, 360 power with good seeing (the short dark line in the shaded area near the center is a photographic defect); November 25, 1952, powers up to 700 with excellent seeing.

Three of my drawings are reproduced here, all made in 1952 with the 8-inch reflector shown on the front cover. On February 4th, there was an oval dark area near Plato's center, apparently a shadow in a shallow depression on the floor, but perhaps a cloud on the lunar surface or an optical illusion; this detail was clear and prominent when observing began, but it disappeared completely within 15 minutes. Fourteen spots, none seen as craterlets because interior shadows were not visible, are shown in this drawing. The four spots near the center, the same as those in the Mount Wilson photograph on page 221, were continuously seen, while the remaining spots were glimpsed momentarily.

The March 7th sketch, made under good seeing conditions, shows 18 spots, 13 corresponding with those seen on February 4th, and at least 10 that may be identified in the Wilkins drawing on page 223.

On November 25th, I was able to use powers up to 700 under the best seeing conditions I have ever experienced. Five craterlets showed interior shadows and one, near the upper edge of the floor, appeared completely filled with shadow. But no other spots were seen than those of February 4th and March 7th, despite several hours of study.

In this third picture, the wedge-shaped "sector" and other light areas show dimly but spots that should be clearly evident are missing. The spot above and right of center, between the two shadow-holding craterlets, was ranked by me then as sixth in ease of visibility, but it was reported as a new and very faint object in 1949! Charts of 1870 to 1900 show this craterlet, but it is missing from later records. Where was it for nearly five decades? And why is it more obvious now than in 1949?

Note that although the November 25th drawing was made with about the same sun illumination and angle as that by Dr. Wilkins on April 3rd that year, the sharp shadow point at the upper left of the floor shows no hook.

As craterlets and spots seem to have appeared and disappeared, so faint light streaks and large splotches apparently have shifted on Plato's floor. Some observers connect these two kinds of changes. In 1892, Pickering reported that the bright streaks had altered materially since earlier observations. He sought to explain these markings in terms of his theory of volcanic activity on the moon.

While the long lunar day advances, the craterlets in Plato's interior become more apparent, contrary to the behavior of most craters elsewhere on the moon. Furthermore, the floor of this great ringed plain becomes progressively darker as the

sun's altitude increases from 20 degrees until after full moon. Both Neison and Elger vouch for this phenomenon, but Dr. Wilkins, writing in 1950, denies its occurrence.

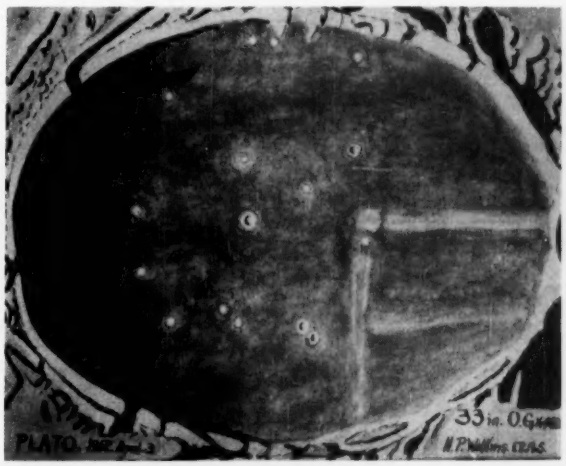
Plato's third riddle may confront us at any time without warning. Suppose you have been looking at this feature for several months. The half dozen most conspicuous craterlets and spots have become familiar and are almost always seen, except when poor seeing converts the floor into a shimmering, shapeless blob. Then one night, with Luna riding high in a cloudless sky, you cross your fingers, mutter the astronomer's prayer, unlimber the 'scope and turn it tentatively on the earth's companion, hoping that tonight you can shove the Barlow clear in, pulling the eyepiece way out for highest possible power.

If you're like me, you may want to approach Plato gradually, saving it as a main course after nibbling at other formations. Perhaps Copernicus is emerging after sunrise. It is a good feature for careful focusing and study of its terraces and central peaks. And to test the seeing you'll turn west to the chain of craterlets, which you find standing steady and clear. Then you look farther west to Archimedes and Aristillus. North down the rugged Alps, and a side swing along the Alpine Valley, for perhaps tonight you can definitely find out whether that darkish spot nestled next to the southern cliff is a craterlet or a rock slide down the wall. It does look like a crater—very round. You test again on those two tiny craterlets just south of Plato—with a little focusing they are clear and steady—it's a good night.

Now to Plato. You look, and look again, and see nothing! Yes, the walls are clear and detailed, and that landslip on the east stands out. But the floor appears smooth, flat, and featureless, perhaps with a faint flickering glimmer of something where you know the comparatively prominent central craterlet should be. You see nothing, but this nothing is the something that has puzzled lunar observers for a century, the apparent obscuration of the floor of Plato at times when floor features should be readily visible.

A striking instance of this temporary blanking out is recorded by Dr. Wilkins in a letter to Mr. Barcroft dated January 9, 1953. The Meudon drawing of April 3, 1952, shows no detail on the eastern

(Continued on page 239)



With the world's third largest refractor, at Meudon Observatory in France, H. P. Wilkins made this drawing on April 3, 1952. Four shadow-holding craterlets of the Mount Wilson photograph on page 221 are seen here, but the fifth, near the right edge of Plato's floor, was looked for in vain, although seeing was excellent. From "The Strolling Astronomer."

LETTERS

Sir:

Here, on the sea coast near Viareggio, I am erecting a small private observatory; there is an ample terrace above my painting studio affording a remarkable view of the whole horizon. I plan to have a small reflector, and would be glad to correspond with other amateur astronomers in the United States.

A cordial welcome is extended to readers of *Sky and Telescope* who might be touring in Italy and passing along the Viale Roma, which is (in this section) the principal motor road from Genoa to Rome.

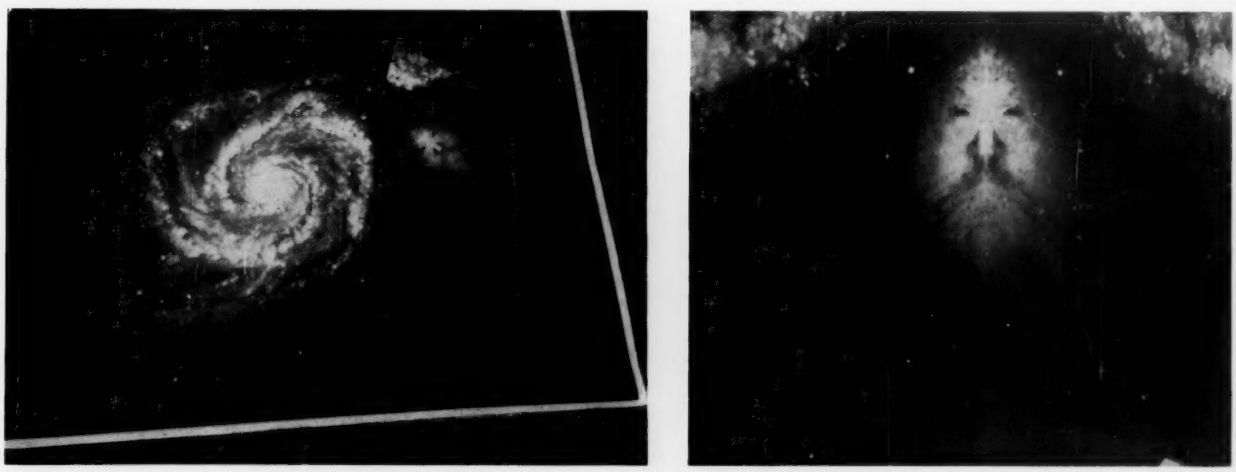
ERNESTO MICHAHELLES
Viale Roma No. 93
Marina di Pietrasanta, Italy

Sir:

The writer, a clergyman and a very amateur astronomer, has happened upon a picturesque figure that may prove to be the most colossal countenance in the visible universe. On December 10, 1954, while contemplating in *Sky and Telescope* the beautiful 200-inch photograph of the famous Whirlpool nebula, I noticed some interesting markings in the companion galaxy, NGC 5195. They have the features of half a man's face.

As the picture at the left shows, I placed a first-surface mirror down the center of the smaller galaxy to produce a striking face, which is seen enlarged at the right. To me the details of the eyes, brows, hair, nose, mouth, and beard are astonishing.

ARTHUR L. GILMORE
63 Auburn Ave., N. E.
Atlanta 3, Ga.



At the left is a photograph of the center picture of the December issue, with a mirror set against NGC 5195. At the right, the effect of the mirror is shown enlarged. Photographs by Arthur L. Gilmore.

Some Astronomical Applications of Image Converters

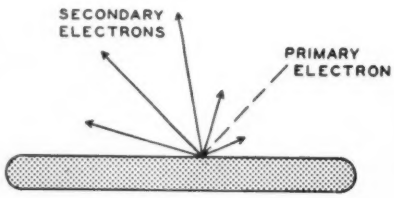
OTTO STRUVE, *Leuschner Observatory, University of California*

TO OBSERVE stars and galaxies too faint for present methods, it is not enough simply to build a telescope larger than the 200-inch, for this will not circumvent the background brightness of the night sky, discussed last month. But can the receptor part of the telescope system—photographic plate, or photoelectric device—be improved to increase the efficiency of the telescope? We have already examined the promises and limitations of photography. What hopes do recent advances in electronics offer?

The photoelectric effect is the ejection of electrons from a metal surface on which light falls. Nearly all metals produce this effect for ultraviolet light, but astronomers are particularly interested in the alkali metals, such as potassium and cesium, for these are sensitive to visible light as well. These metals are attacked by atmospheric oxygen, however, and a light-sensitive film composed of one of them must be enclosed in a vacuum tube or in a tube containing a rarefied inert gas.

In a simple photoelectric cell, the negative electrons released by the light are collected by an anode, the latter being positively charged relative to the film of alkali metal that forms the cathode. As long as the cell is illuminated by incoming light, electrons stream from the cathode to the anode, and an electric current flows through the circuit of which the cell is a part. The value of photoelectric cells for photometry arises from the fact that the intensity of this *photocurrent* is proportional to the intensity of the incident light.

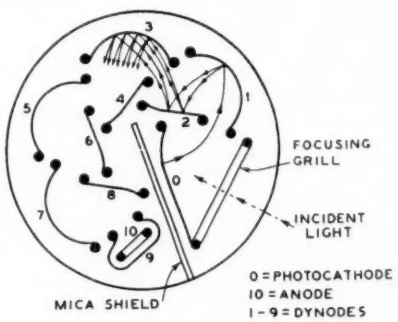
More complex photoelectric cells take advantage of the fact that the electrons released by the light will themselves release electrons when they strike another suitable metallic surface. The number of secondary electrons thus produced depends on the speed of the striking particles. These can be made faster by increasing the electrical potential difference between the first and second surfaces. With most metals, it is possible to obtain two secondary electrons from a single primary, and for certain alkali metals the yield may be as great as 10 to one.



Secondary emission: a fast electron ejects others on hitting a surface of suitable material.

This phenomenon has been exploited in the photomultiplier tubes that are now so extensively used by astronomers. In a typical RCA 1P21 tube there are nine successive stages of amplification, with a potential difference of 90 or 100 volts between successive cesium-oxide films. The efficiency of individual tubes varies, but one tube in use at Lick Observatory some years ago had an amplification of 5.5 at 90 volts per stage. Therefore, every primary photoelectron from the first surface of this tube released $(5.5)^9$ or 3.7 million electrons in the ninth stage. This enormous multiplication of the photoelectric effect means a correspondingly great sensitivity of the tube.

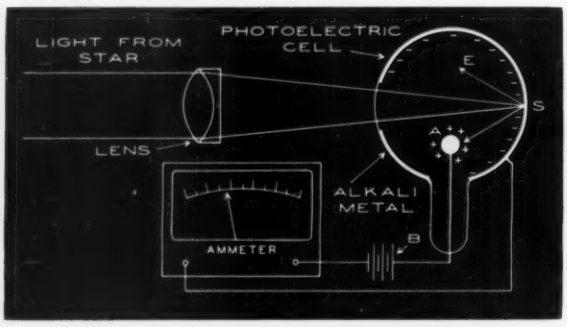
It is important to know the quantum efficiency of the primary receiver surface. This is defined as the number of electrons ejected per incident quantum of light. Direct measurements have shown that this ratio is about 1/10—only one out of 10 incident photons liberates a primary electron. Even so, this quantum efficiency is about 100 times greater than that of a fast photographic emulsion—an enormous advantage.



This schematic drawing illustrates the operation of an RCA 1P21 photomultiplier tube. The arrows show the paths of a primary electron, released as light falls on 0, and of secondary electrons as they cascade through the nine dynode stages to the collector anode. The entire tube is two inches long. From the "Journal" of the Optical Society of America.

There now exist several other light-sensitive devices with higher quantum efficiencies than the photoelectric cell, for certain wave-length regions. Of these the most important is the photoconductive cell, based on the fact that the electrical resistance of some substances is greatly reduced by the absorption of radiation. For instance, the resistance of a thin layer of lead sulfide or thallium sulfide decreases enormously when it is illuminated with infrared light.

The current flow through a photoconductive cell is directly proportional to the intensity of light at the wave



The simplest form of photoelectric photometer. As light falls on the cell, the ammeter readings are accurately proportional to brightness. The battery B applies a positive potential to the anode A, so that it collects the photoelectrons E released from the cathode at S.

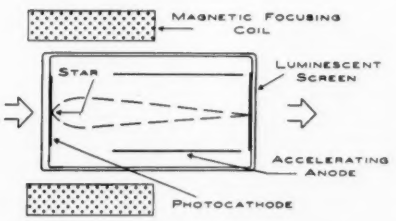
lengths to which the cell is sensitive. The quantum efficiency of a photoconductive cell is as high as 1/2; the infrared sensitivity may be 100 or 1,000 times that of the best cesium-oxide photoelectric tubes, but in short wave lengths the gain is less spectacular.

The quantum efficiency of other types of receivers is somewhat smaller. That of the thermopile, consisting of a series of bimetallic junctions (thermocouples), is about 1/20, but this is still 50 times better than that of the photographic emulsion.

These photocell advantages have been fully exploited in modern astronomical photometers, which can measure the brightness of any star that can be detected with a long exposure on a fast emulsion. Nevertheless, as we saw last month, high sensitivity is no essential advantage when stars of apparent magnitude 23 or 24 are observed with the 200-inch reflector—their images are already nearly drowned out by the brightness of the night sky.

Another limitation of conventional photoelectric equipment is that it does not reproduce an image of the field. If we know beforehand where a star is located, we can measure its brightness, but we cannot reconstruct the field of neighboring stars, as is done in direct photography.

In principle, this latter problem has been solved through the invention of television. But the methods of commercial television are not readily adaptable to the extremely faint light sources encountered in stellar and nebular astronomy. What we require—in order to take full advantage of the high quantum efficiency of photoelectric receivers—is a way to transform photoelectrons liberated from a suitable cathode surface in the focal plane of a telescope into photographic grains on a plate, retaining the spatial arrangement of the areas on the



In this cross-section view of an image converter tube, photoelectrons are focused on the screen at the right, forming a brightened visible image.

cathode that are affected by the light of individual stars and nebulae.

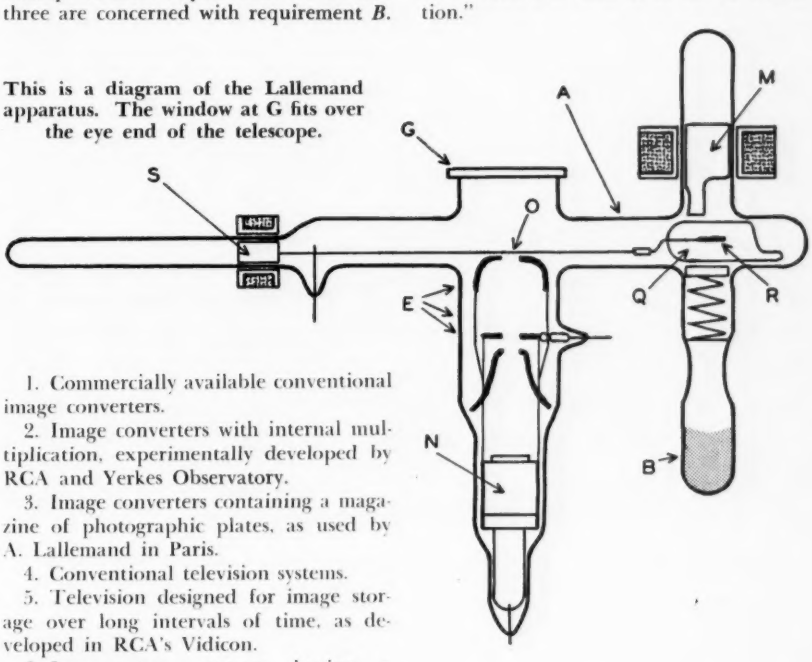
W. A. Baum, of Mount Wilson and Palomar Observatories, has thus summarized the requirements:

"*A.* We wish to deliver an intensified image to an exceedingly fine-grained emulsion whose speed is prohibitively slow for direct unaided photography, but which possesses very small grains and therefore permits us to reduce the root-mean-square error of the number of grains within a 'picture element' of one square second of arc [as defined in the preceding article]. Or,

"*B.* We could try to subtract most of the uniform sky background brightness electronically before the intensified electronic image is delivered to the photographic emulsion."

In a report to the Carnegie Institution of Washington, Dr. Baum has discussed six possible mechanisms. The first three attempt to meet requirement *A*; the last three are concerned with requirement *B*.

This is a diagram of the Lallemand apparatus. The window at G fits over the eye end of the telescope.



1. Commercially available conventional image converters.
2. Image converters with internal multiplication, experimentally developed by RCA and Yerkes Observatory.
3. Image converters containing a magazine of photographic plates, as used by A. Lallemand in Paris.
4. Conventional television systems.
5. Television designed for image storage over long intervals of time, as developed in RCA's Vidicon.
6. Image-storage systems having a photoemissive cathode, as proposed by J. D. McGee, of the Electrical and Musical Industries of Great Britain.

The operation of an image converter is shown in the diagram. The photoelectric surface is a semitransparent film deposited on the inside of a cylindrical vacuum tube. The star field in the focal plane of the telescope is projected upon this surface, with, perhaps, the image of a star at the point labeled. From this point of great light intensity, primary electrons are ejected in all directions. These electrons are focused by a magnetic coil surrounding the tube; this is similar to the focusing action in electron microscopes. The electrons are accelerated by the tubular anode and form an image upon the luminescent screen.

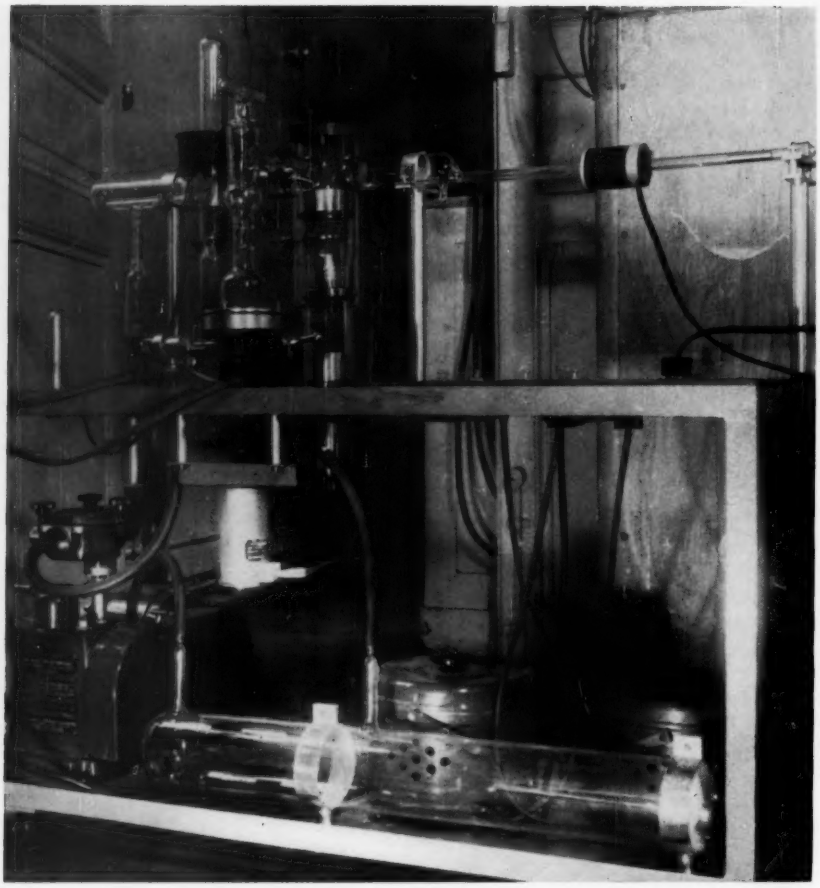
Each fast electron striking the screen generates a burst of as many as 100 photons. Hence, even if the quantum efficiency of the photocathode is only 1/10, the over-all optical multiplication is 10. But the photons are ejected from the screen in all directions, and even as fast a camera as f/1 could catch only about 10 per cent of them. This reduces the final efficiency by a factor of 10, giving us no gain with respect to the original image.

W. A. Hiltner, of Yerkes Observatory, has experimented with the second system, in which several image converters are placed in series. Each luminescent screen activates a new photocathode separated from it by a thin membrane. Dr. Hiltner reports that a 100-fold gain can be achieved with three stages, but a cascaded voltage of at least 10,000 volts per stage is required. Moreover, there is a substantial loss of definition due to the membrane separators. He concludes, "This does not seem to be an ideal solution."

Mechanism 3 has been used by Lallemand and his associates. In his device a photographic plate replaces the luminescent screen of the image converter. The latest design, perfected by Lallemand and M. Duchesne, is shown here schematically. The photocathode *R* is first prepared in a small evacuated tube *Q*, which is sealed in a larger pyrex glass tube *A*. Light enters through the window *G*. The chamber *N* contains a number of photographic plates of Kodak type NT2a used for nuclear research.

After the larger tube *A* has been evacuated, and the plates sufficiently outgassed, a magnetically operated hammer *M* breaks and destroys the small tube *Q*. The photocathode is then magnetically pulled by means of the coil *S* into the operating position at *O*. The electrons are focused and accelerated by means of the three electrodes indicated by *E*, and they pass from the photocathode at *O* to the topmost of the plates at *N*. During this process, the vacuum is preserved by activated charcoal at *B*, which absorbs residual gases.

The photographic emulsion is highly sensitive to fast electrons having energies

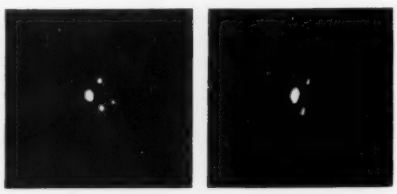


A vacuum pump is being used to exhaust the air from Lallemand's apparatus, prior to its attachment to the telescope for observation. The wide vertical glass tube houses the plate magazine and the electrodes for focusing the photoelectrons. From its right side extends a slender horizontal tube carrying a black cylinder, which is the coil marked S in the diagram on page 225. Photograph, courtesy A. Lallemand.

of the order of 40,000 electron volts. Hence, an important saving in exposure time can be realized by Lallemand's method. The response of the emulsion is almost linear, thus avoiding trouble caused by reciprocity failure in direct photography. Moreover, there is less general fogging.

The complexity of Lallemand's procedure is due to technical difficulties. The antimony-cesium photocathode can be ruined by various gases that are occluded in the photographic emulsion, these gases gradually escaping after the space around them is evacuated. Therefore, the plates must be outgassed before actual observing can begin. This takes time and requires refrigeration, but the latter process disintegrates the gelatin of the emulsion. While this outgassing is going on, the photocathode is safe from contamination in its small tube *Q*. Since it is not possible to eliminate all gases, the photocathode loses some sensitivity during the exposure. It is completely spoiled when the device is opened to extract the plates for developing; a new, sealed photocathode is required for the next series of exposures.

The French astronomers have successfully coped with some of these problems. They have tried more resistant antimony-cesium photocathodes, containing an excess of cesium. They have introduced various devices for improving the vacuum without spoiling the emulsion. The whole apparatus has been designed so it can be attached to the eye end of a movable telescope.



An early test photograph with Lallemand's image converter is at the left, exposed for five seconds on the multiple star Theta Orionis. The other picture is an ordinary photograph, exposure time three minutes, taken with the same telescope on the same night. This does not show the fourth star in the Trapezium.

By 1951, Lallemand had succeeded in photographing with his apparatus a laboratory source completely invisible to the eye. When a direct photograph was made on a Superfulgur emulsion replacing the photocathode, a six-hour exposure yielded about half as strong an image as was obtained in four minutes with the image converter. A similar comparison of the Trapezium in Orion was made, as shown here. The elongation of the stars in the ordinary photograph is caused by image rotation in the small coude-type telescope that was used.

The Lallemand method has achieved an average saving in exposure time of at least 50. But, as Baum has stressed, this method is not "capable of doing anything to a picture (background and all) except intensifying it; one obtains no fundamental gain in discriminating faint images against the background except in so far as the use of finer-grained slow-speed emulsions might help." Nevertheless, Lallemand's procedure constitutes an enormous advance. While it will not enable us to discover stars and galaxies beyond their present limit of magnitude 24, it could be used to observe high-dispersion spectra of faint stars now beyond the reach of conventional spectrographs on even the largest telescopes.

Baum is primarily concerned with the problem of intensifying only the star images without at the same time enhancing the background brightness of the sky. He points out that with an ordinary photocathode we could deliver to the emulsion 100,000 charges per picture element of one square second of arc, instead of only 1,000 as on a direct photograph. The root-mean-square fluctuation would then be only 3.3, instead of 33. If we could subtract 90 per cent of the background from all over the receiving surface, we would obtain a photograph which would look exactly the same as the unaided picture, except that all star images would be relatively strengthened by a factor of 10, and the limit of detection would be 2½ magnitudes fainter than before. We might then record stars and galaxies to magnitude 26½ with the 200-inch telescope!

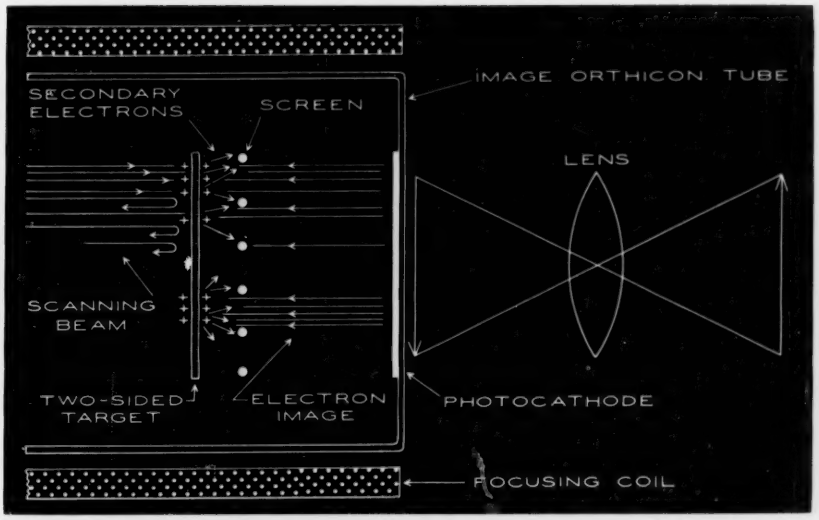
As we have said, ordinary television technique is not adapted to faint sources. The Vidicon produces spurious images. Problem *B* has not yet been solved, and Baum remarks that it may be rather far in the future, if it is possible at all. But he favors a modified television procedure, as recommended by McGee in England.

In order to understand this method, let us examine the accompanying diagram illustrating what happens in the conventional Orthicon pickup tube of a television camera. The optical parts, represented here by a simple lens, form an image of the object on a photocathode

at, say, a negative potential of 300 volts. The primary electrons released from the photocathode by the light in the image are drawn in straight lines to a two-sided target at zero potential, but they pass through a mesh or screen before striking it. Each primary electron generates several secondary electrons that travel in the opposite direction and are caught by the positively charged screen; these secondary electrons thus are removed from the system. If the mesh is wide enough, its obstruction to the primary electrons is relatively unimportant. There remains upon the two-sided semiconducting target a nonuniform distribution of positive charges which is a replica of the original optical image.

For television transmitting purposes, an electron gun sprays the back side of the target with electrons, the scanning taking place along closely spaced horizontal tracks. Where an electron hits a positively charged area on the target it sticks to the target, but where it encounters an area of zero charge it is reflected in the direction of the gun and becomes part of a modulated return beam which is collected by an electron multiplier tube. The amplified output of this beam becomes the "video" signal and can be broadcast to distant television receiver sets.

In McGee's design, the target or dynode is a thin glass plate having a nonconducting cesium-treated face and a conducting layer on the back. The mesh removes the secondary electrons, as in the television case. Positive charges are stored on the face of the dynode—again forming a replica of the optical image. Since the sky is luminous, the entire dynode is covered with spots of positive charge. But in each star image, the charge is greater.



The operating principle of an Orthicon tube, originally developed by RCA as a television pickup device, is shown here. In astronomical use, starlight falling on the photocathode would result in a lasting pattern of electrical charges on the left-hand side of the target. The part of the pattern due to sky light would be erased electrically and the remainder would be converted to a visible picture.

Thus far we have not intensified the star images relative to the sky background, but the target retains the star-field pattern for several hours because its surface film is nonconducting.

McGee's next step is to remove the target-dynode from the apparatus and to spray its front surface *evenly* with slow electrons. This could be done by illuminating a new photocathode through a diffusing ground glass. New, slow primary electrons would be produced and made to fall uniformly over the entire dynode surface, without producing new secondary electrons. The positive sky background charges would be canceled, thus removing that background. The star images, although weakened by the same amount, would now stand out on top of an effectively neutral background.

The rest of the technique would resemble conventional television. A spray of electrons from an electron gun would scan the back side of the dynode and be amplified by a photomultiplier. The brightness of the displayed output could be adjusted for convenient photographic recording.

Although this design looks promising, Hiltner has remarked, "Thus far, good definition and high yield have not been technically compatible." All available secondary emission structures, such as fine mesh screens, thin membranes backed with beryllium, and Venetian blinds of fine mesh, impair definition.

Lallemand's device has been designed for direct astronomical observations on an equatorially mounted telescope. Here it is shown ready for use, attached to a small refractor at the Paris Observatory. Photograph, courtesy A. Lallemand.

NATIONAL ACADEMY TO MEET

The 92nd annual meeting of the National Academy of Sciences will be held in Washington, D. C., on April 25-27. Sessions for papers, which nonmembers may attend, will be at the academy building on the 25th at 10 a.m. and 2 p.m., and on the 27th at 9 a.m. and 2 p.m.

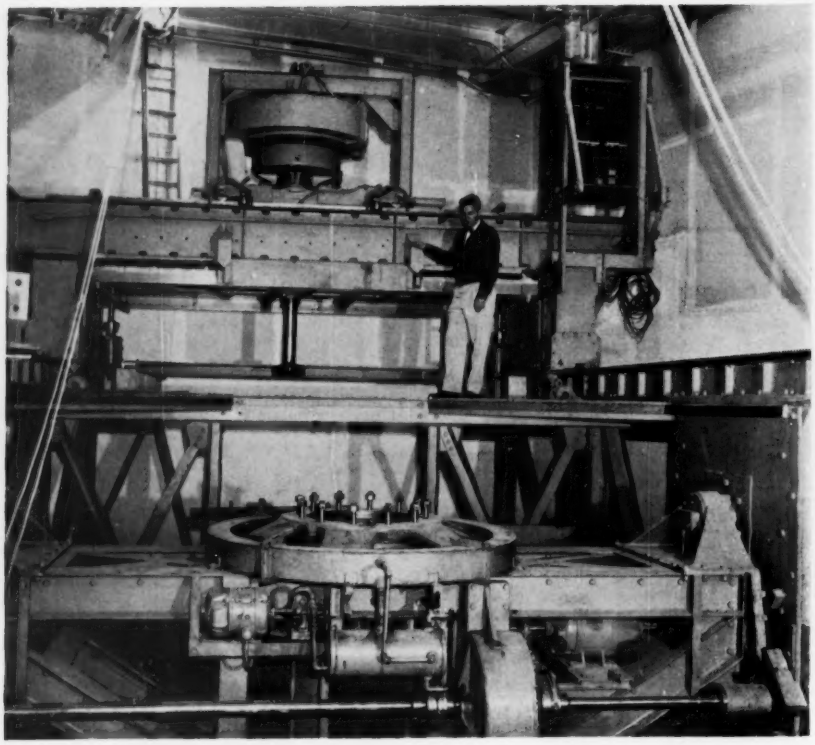
The Elliot medal and the Public Welfare medal of the academy will be presented at a public meeting on April 25th at 8 p.m., followed by a science exhibit.

Lick Observatory

120-INCH ALBUM

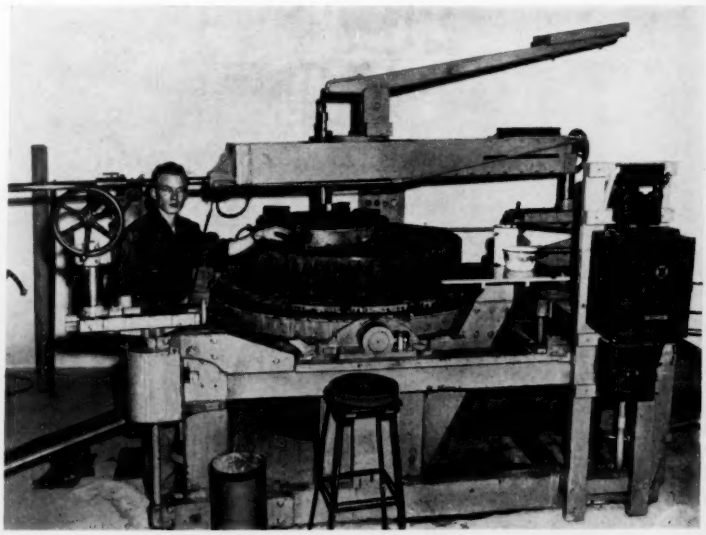
J. F. CHAPPELL
AND W. W. BAUSTIAN
Lick Observatory
University of California

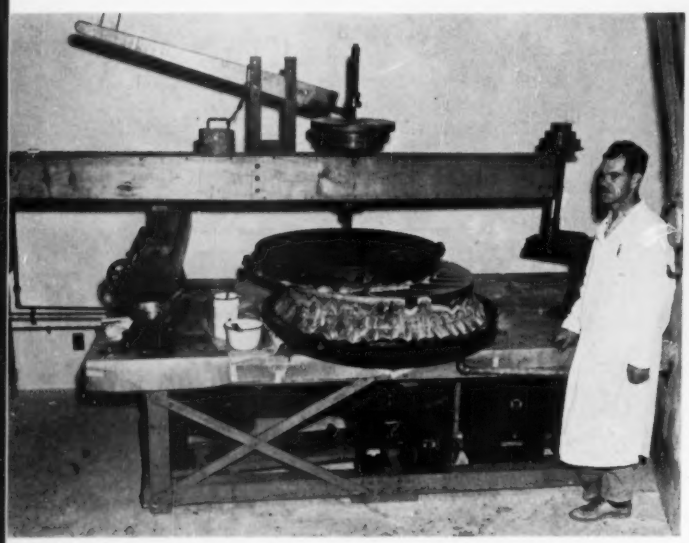
This is the second installment of a picture story on the construction of the world's second largest telescope, the 120-inch reflector at Lick Observatory. The first section was published last month, and the album will continue in the May issue. A short article on the history of the project and plans for observing programs using the instrument also appeared last month.

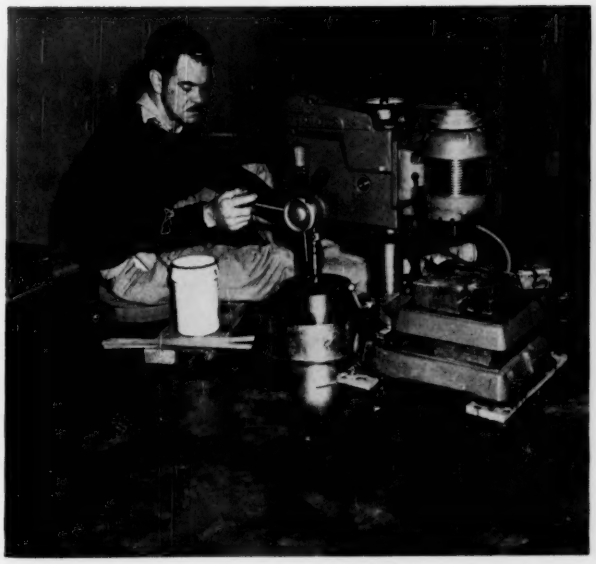


April 3, 1952. The 120-inch grinding machine, purchased from California Institute of Technology, is installed in the basement under the new dome. In practice, this machine was converted to a Draper type, and the traveling bridge, in front of which Dr. N. U. Mayall stands, is used only for handling tools and equipment. It also carries the control panel for the whole machine.

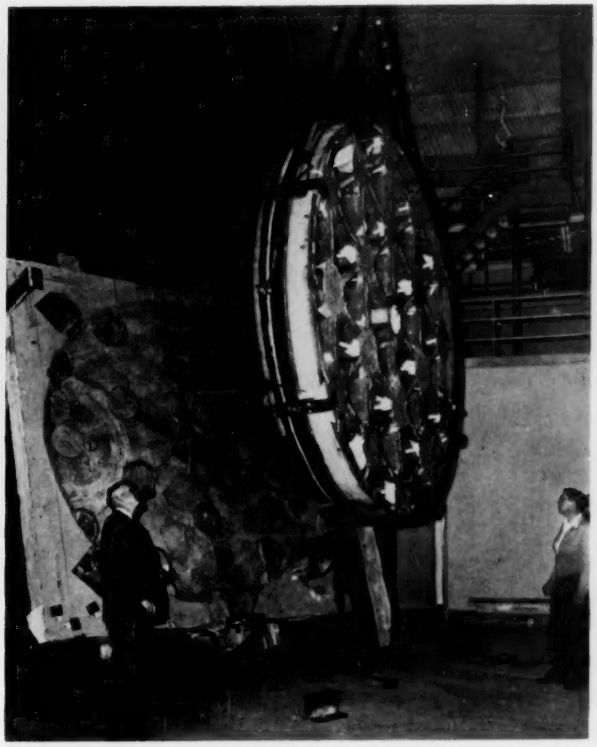
January 22, 1953. These pictures show work on some smaller auxiliary mirrors that began before the grinding of the primary mirror itself. At the right, Jack Spalding is using a half-diameter tool on a 50-inch mirror of 160 inches focal length; below, Howard Cowan is roughing out a 36-inch mirror of 80 inches focal length. Both mirrors are for the coude spectrograph cameras. Draper-type grinding machines are being used. The one at the right was built over 50 years ago by G. W. Ritchey for the 60-inch mirror at Mount Wilson Observatory. This machine, seen here considerably modernized, is described in Part VII of "Amateur Telescope Making—I." The tool is carried by the heavy horizontal arm, and its pressure on the mirror can be reduced by weighting the counterarm. While the machine is in operation, stroke length may be changed by repositioning the crank pin on the driving crank at the right, and the area of mirror being worked may be controlled by resetting the pivot in the transverse ways by means of the hand wheel at the left. The pivot above the stool is one of the mirror table trunnions which allow the mirror to be tilted upright for testing.



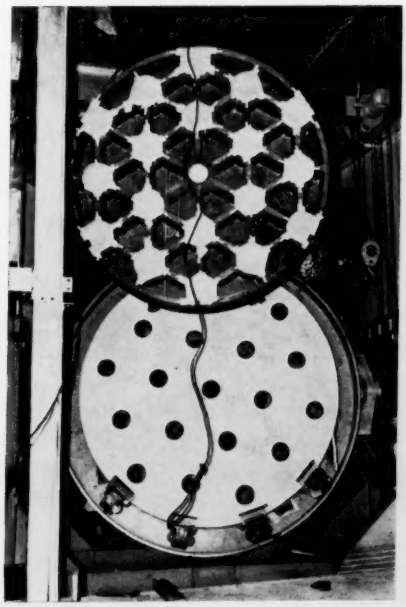




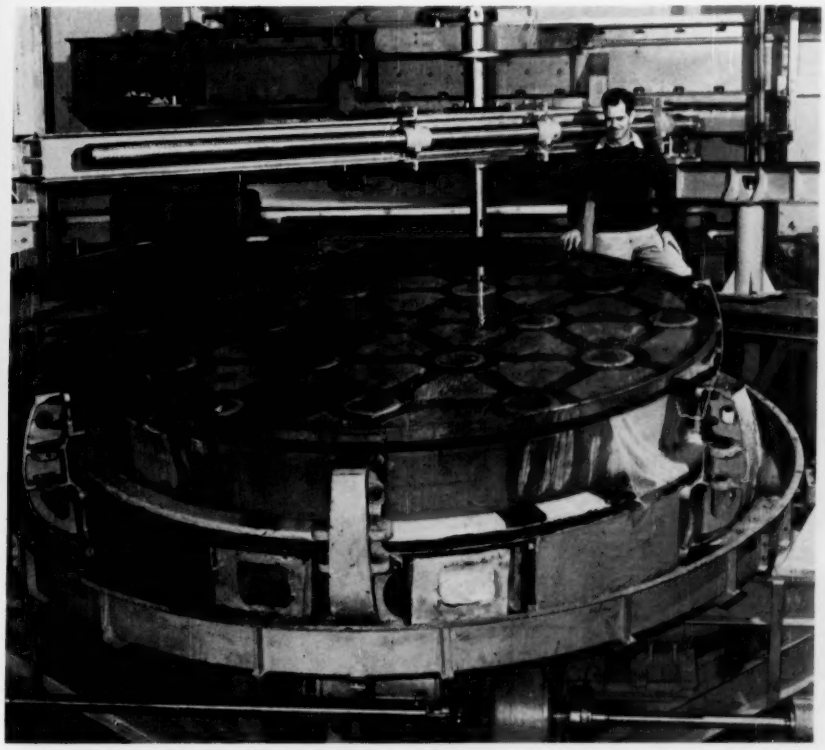
February 5, 1953. A hole eight inches in diameter is being cut by Mr. Cowan through the center of the 120-inch mirror blank, to permit use of the telescope as a Cassegrainian. The steel biscuit cutter was driven by a half-inch drill press with a double speed reduction. The center plug was reinserted, to remain in place until figuring is completed.



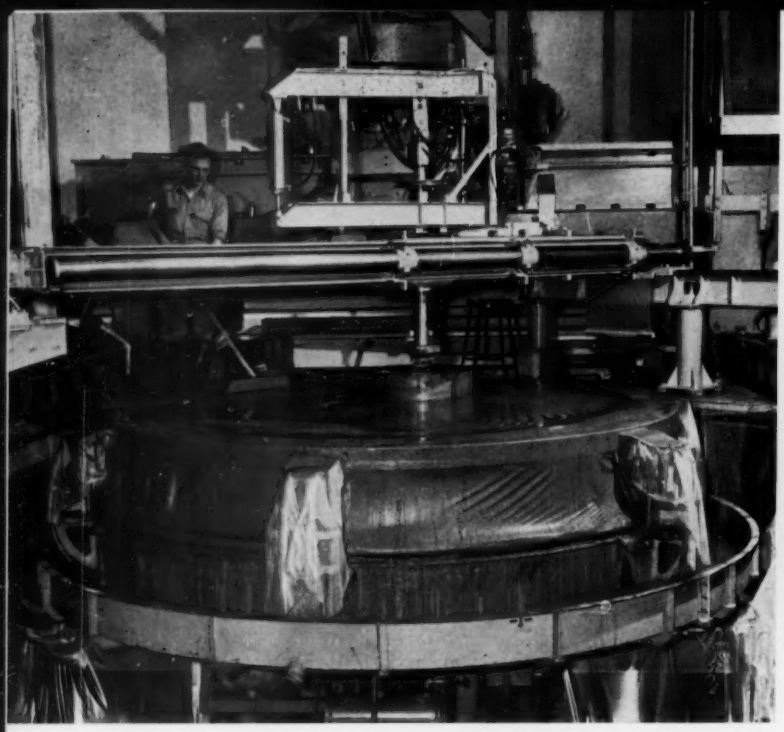
February 6, 1953. Lick Observatory Director C. D. Shane watches as the four-ton mirror is being hoisted off its shipping base to be transported to the grinding machine. The overhead crane is a permanent installation in the dome.

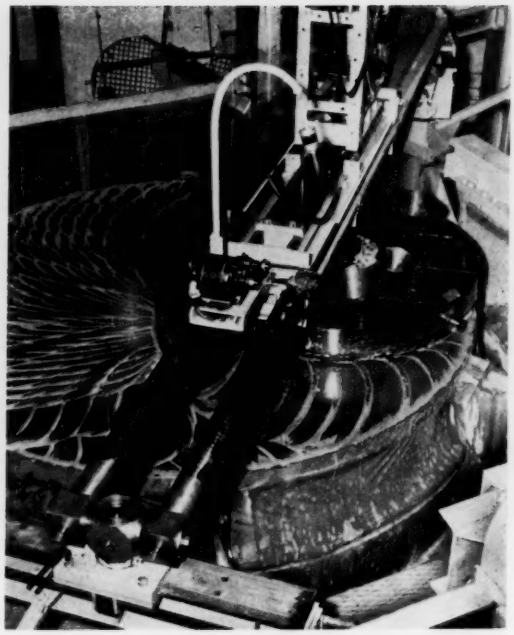


February 6, 1953. The mirror is being lowered through a hatch in the dome floor for mounting on the grinding machine. Each of the mirror support sockets has been covered with paper for protection. The mirror will be turned around, and the side seen here placed against the pad of two-inch sponge rubber that will support it during the roughing and grinding operations. Holes cut in this sponge rubber match the support sockets in the back of the mirror.



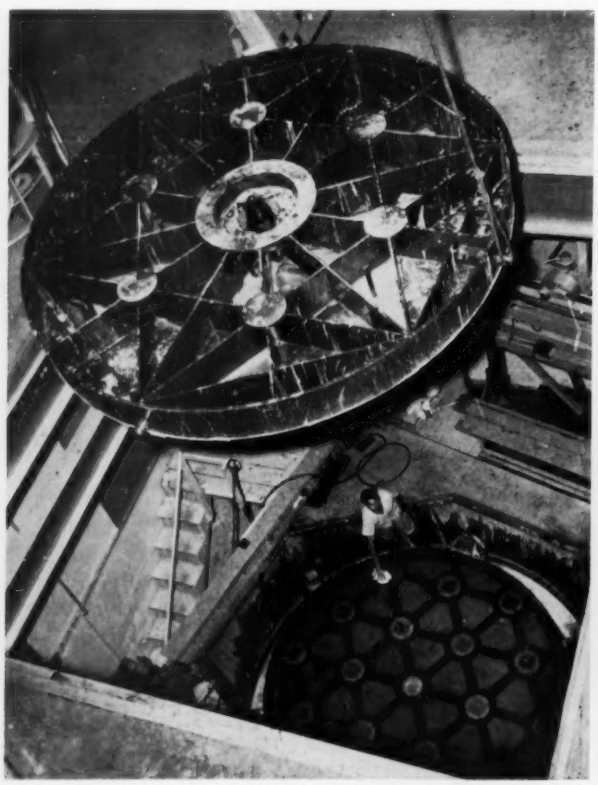
April 10, 1953. The mirror has been fine ground to a flat. Here its surface is wet to produce transparency and show the ribbed structure of the back.





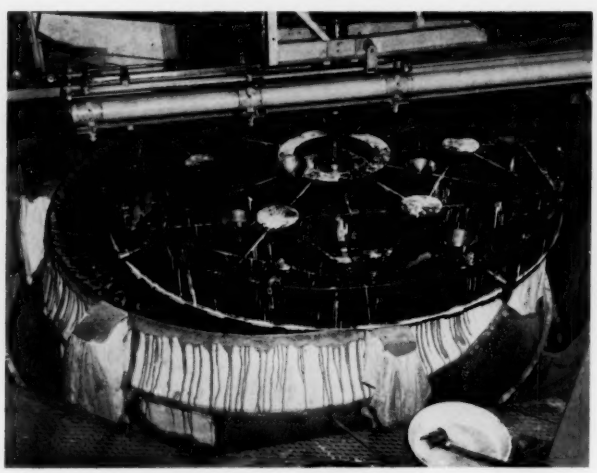
Above left: May 20, 1953. Rough grinding the 120-inch disk took 80 hours. Here a cast-iron doughnut-shaped tool is used, with outer and inner diameters of 24 and 16 inches. A two-horsepower motor spins the 400-pound tool at 80 revolutions per minute, while the Draper arm moves the tool across the mirror 12 to 20 times a minute. Above the arm is the spindle carriage, which contains a pivoted lever at the top. Of four vertical light-colored components, the one at the left is an air cylinder used either to add load to the lap spindle or to subtract it. The range of Draper arm crank speeds is six to 50 revolutions per minute. With this machine it is possible to adjust the Draper arm speed, the air pressure in the air cylinder, the spindle location on the arm, and the pivot location of the Draper arm, all by remote control and without stopping the machine.

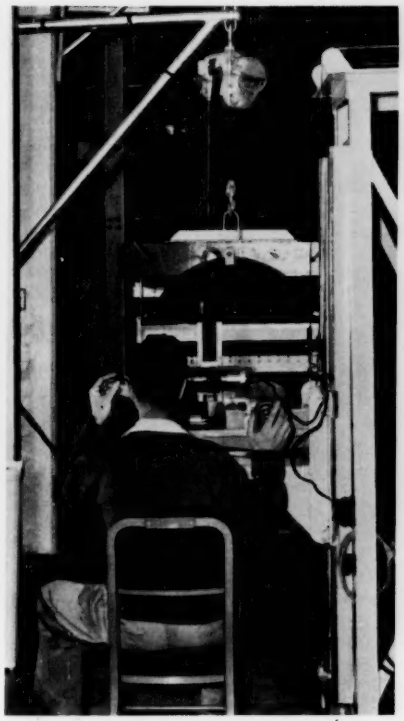
Above right: July 1, 1953. A 60-inch welded-aluminum tool is beginning fine grinding. It is faced with 4-inch square unglazed tiles, three quarters of an inch thick. In the lower left is seen part of the long screw that controls the position of the Draper arm pivot.



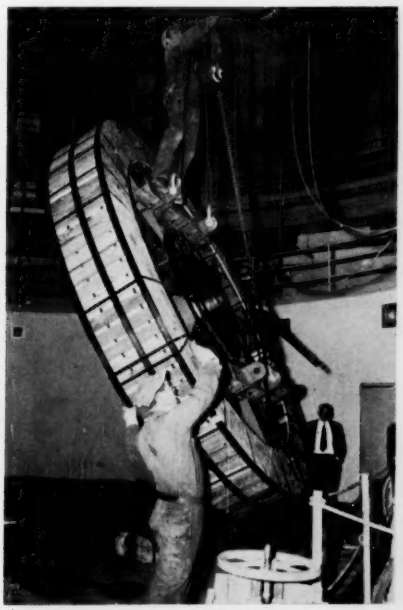
Left: July 31, 1953. This picture, taken from the gallery, shows the full-diameter welded-aluminum tool being lowered through the hatch into the optical shop where the 120-inch blank is seen.

Below: July 31, 1953. The 120-inch tool is also faced with 4-inch tiles. For the later stages of fine grinding garnet powder was used. The funnels lead to small pipes for adding abrasive and water.





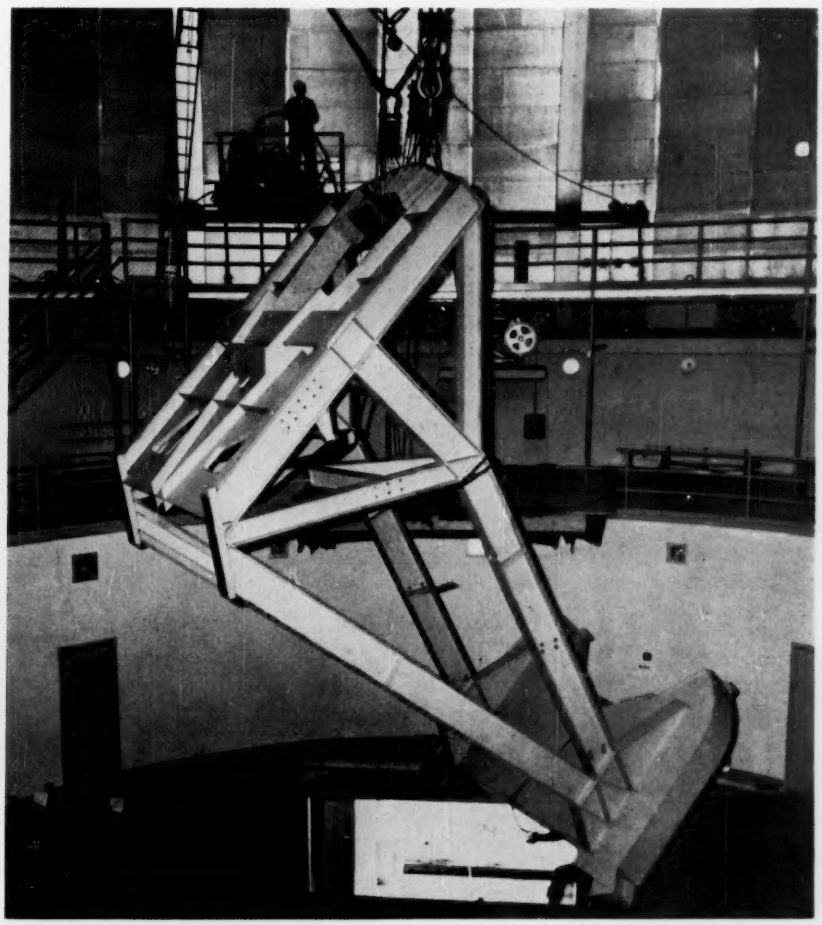
January 18, 1954. A knife-edge test is made of a 36-inch auxiliary mirror, in front of which is a zone marker. The testing device and its supporting stand (partly visible to the right) were purchased from the 200-inch project. The ways and cables leading to counterweights permit raising or lowering the apparatus.

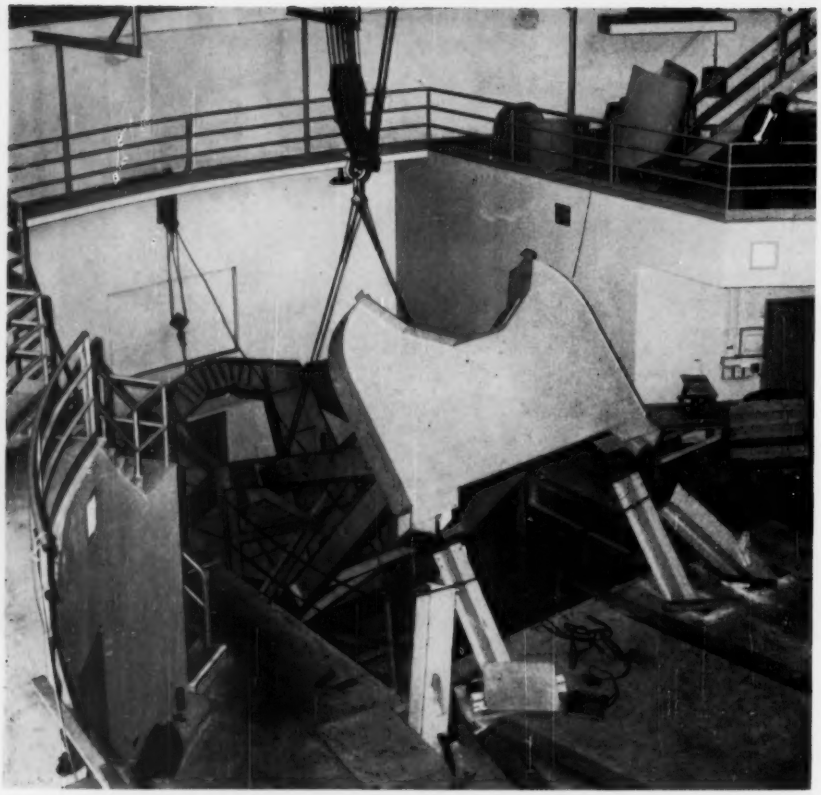


January 19, 1954. The $70,000 right-ascension driving gear arrives in the observatory, its edges well protected from damage in transit.

Above: January 29, 1954. The base frame is being trucked up Mt. Hamilton. It is upside down, and its south end, 16 feet high, is toward us.

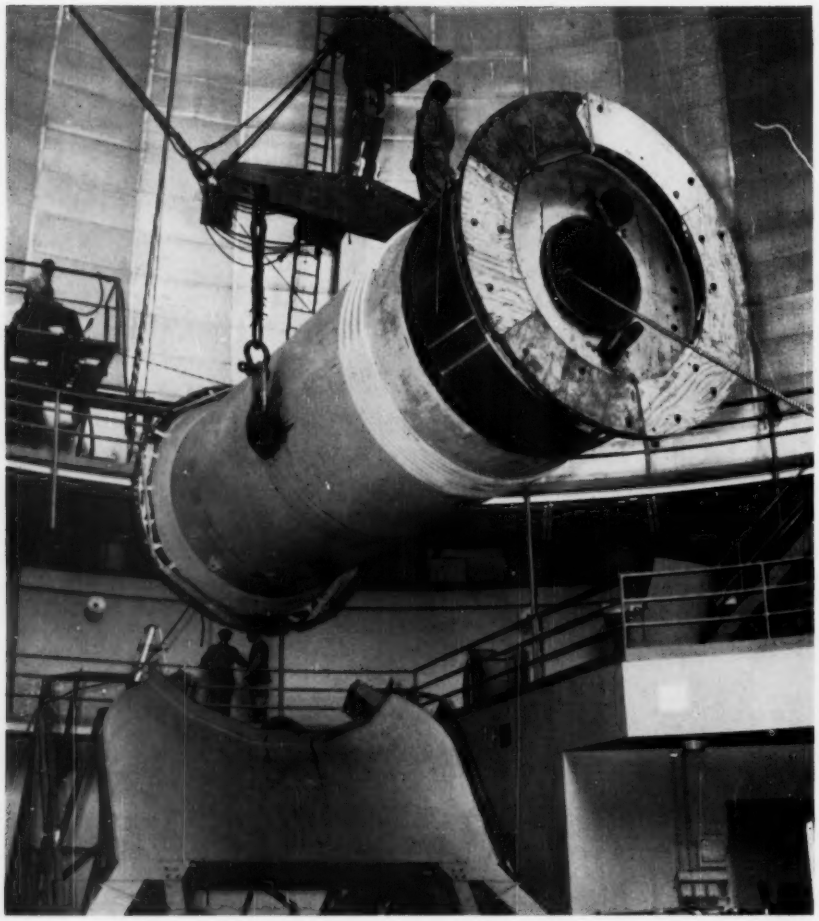
Below: February 1, 1954. The base frame has just been raised through the entry hatch into the dome. It is about 22 feet long and 12 feet wide.





Left: February 1, 1954. The base frame is almost set in its final position, thus filling the pit in front of the coude room that was seen in the picture on page 184 last month. At left center, note the reinforcing ribs on the arch at the south end of the base frame. Two oil-pad bearings on the inside of the arch will press down on the lower end of the polar axle, for at this point the upward thrust of the telescope and fork will be 75 tons.

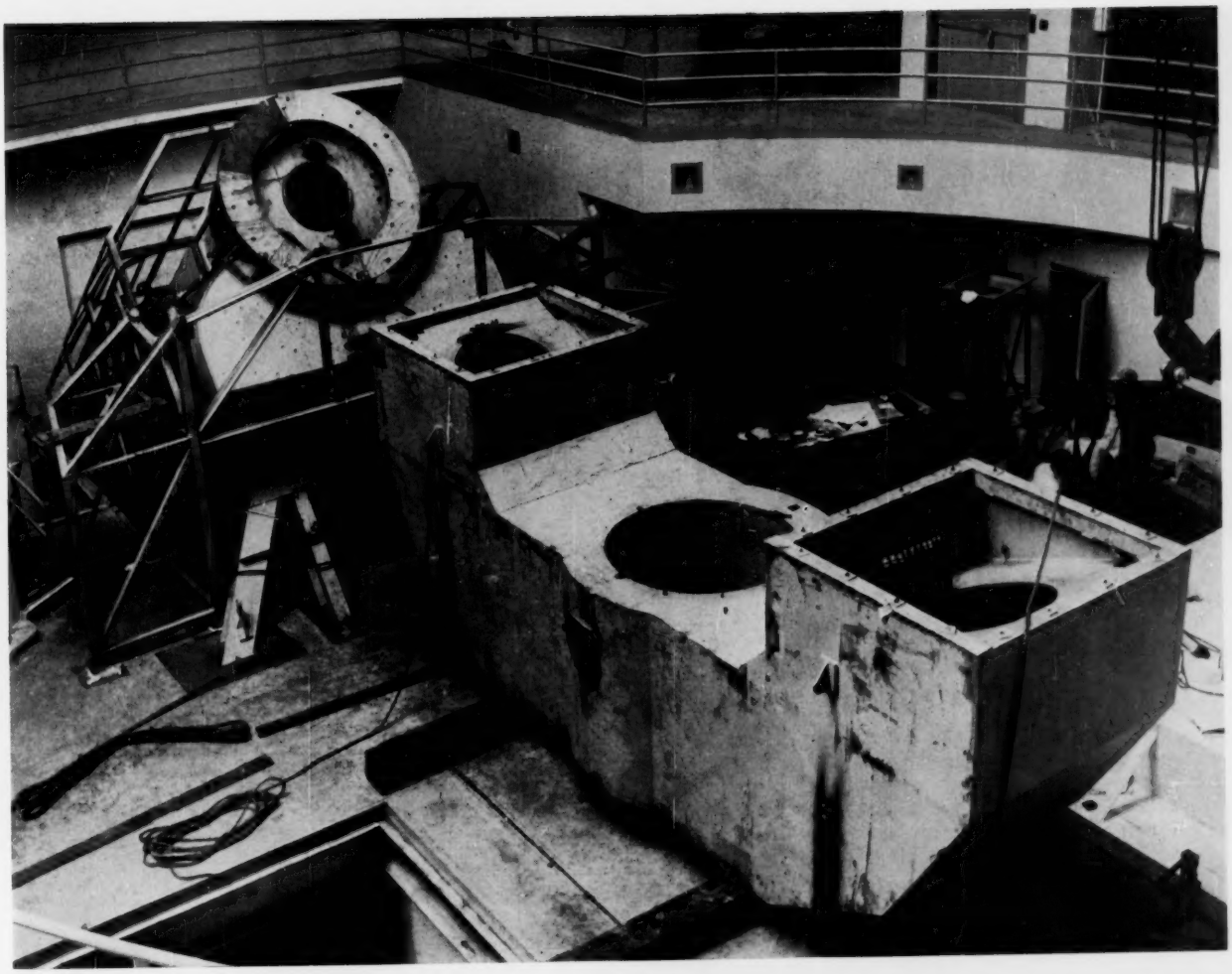
Below left: March 8, 1954. The 34-ton polar axle is being installed in the base frame. This 24-foot tube of welded steel is seven feet in diameter at its north (upward) end, and is stepped down to four feet at the south end, which fits into the arch on the base frame. The center of the axle is unobstructed to permit passage of light down its length to the coude focus. The north journal surface appears shiny and dark; this important bearing is circular to within 0.002 inch. The north journal and flange are of cast steel, with the journal wall thickness four inches.

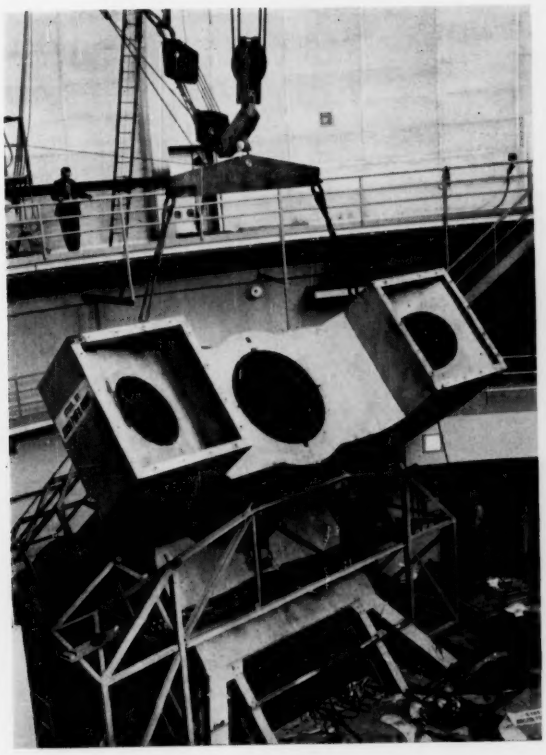


Facing, top: March 23, 1954. The yoke section of the fork lies on the floor, prior to being mounted on the polar axle that is seen in place in the background. Weighing 33 tons, this section is 25 feet long, and stands 10 feet above the floor. The flange ends of the yoke are 74 inches square. The maximum wall thickness of this section is $1\frac{1}{2}$ inches.

Facing, lower left: March 25, 1954. The crane is lowering the yoke section into place on the north end of the polar axle.

Facing, lower right: March 25, 1954. The yoke is being attached to the polar axle. To eliminate flexure at this joint, 32 alloy steel bolts, each two inches in diameter, have been tightened until they are preloaded to 40,000 pounds per square inch, or 60 tons in a three-inch cross-section. The journal surfaces of the polar axle carry a wooden shield against accidental injury. Portions of the fork access platforms extend across the upper part of the picture.

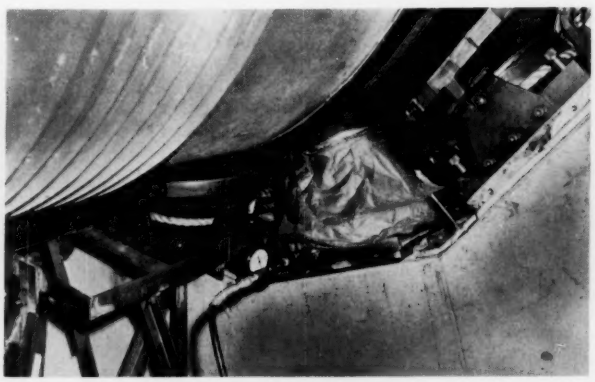


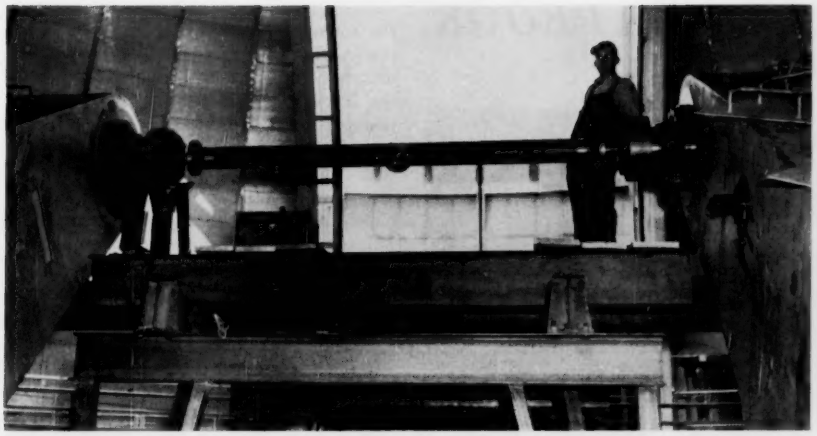


Above: April 28, 1954. The massive fork for the telescope is now complete. The fork arms that have been added to the yoke are 21½ feet long and weigh 12 tons each, bringing the total fork weight to 57 tons. They taper from 74 inches square at the yoke to 42 inches square near their ends. The plate thickness diminishes from one inch to ⅝ inch at the ends. Each fork arm is held to the yoke by 68 1½-inch-diameter alloy steel bolts, prestressed to 36 tons each. The east declination stub axle is shown in place.

Below left: April 7, 1954. The 120-inch mounting will turn in right ascension on oil-pad bearings, each of the five oil pads requiring a gallon of oil per minute, circulating at a pressure of about 900 pounds per square inch. Two sets of pumping equipment are shown here, either pump being able to supply the demand. The tank at the left removes water in the oil caused by condensation; the tanks on tall legs are reservoirs; the cylinders are rough filters, connected to the two pumps at the lower right in this picture.

Below right: May 3, 1954. The oil pads are being installed under the north end of the polar axle, which is temporarily raised on a hydraulic jack (wrapped in paper). The right pad is in place, but has not yet been lifted up by spacer shims. The left pad is being slid into position from the installation fixture. These two pads will carry a load of about 150 tons.

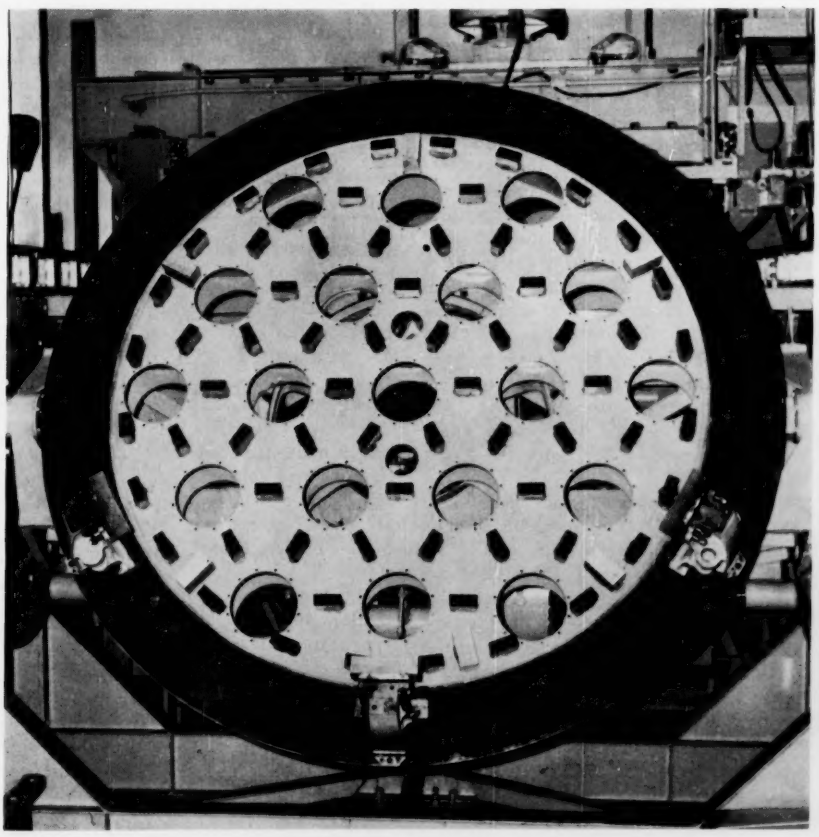




Above: May 7, 1954. The west stub axle is being lined up with the east axle by means of an alignment bar and a plane-parallel mirror (not shown) mounted on the circular plate at the center of the bar. With an autocollimator placed at the coude focus, it was possible to adjust within one second of arc; the line joining the stub axles is less than five seconds out of perpendicularity with the polar axis. Protruding from the inside of the right (east) fork may be seen the shaft for the pinion gear that will engage the large declination gear; the interior of this arm is shown in the photograph at the right.

Above: May 7, 1954. W. W. Baustian is seen inside the east fork arm. The vertical cylinder at the left contains a tangent screw which provides a slow motion in declination of two degrees either way, by controlling the position of a square radius arm (seen beyond the screw casing). This radius arm, on which is mounted the fast-motion drive unit, transmits the slow motion through the locked fast-motion pinion. For fast setting the pinion revolves independently of the arm.

Below: May 24, 1954. This is the cell that will support the 120-inch mirror in the telescope. Here it has been mounted on the grinding machine for later stages of work on the mirror. The small black rectangles are sponge-rubber cushions to take the added weight of the tool during grinding and polishing. Before final polishing is begun, however, the 19 specially designed counter-weighted mirror supports will be installed in the back of the glass disk.



Below: June 10, 1954. The back of the mirror has been fitted with bearing races (in the circular pockets) and bearing shoes (one seen in a triangular pocket). These will later allow accurate optical collimation of the mirror, and will form part of the system that will support it in all positions. The front face of the mirror is only 2½ inches thick at the center, but the ribbed structure will take all the load stresses.

ASTRONOMICAL SCRAPBOOK

The Sadler-Smyth Scandal

A REMARKABLE impression has been left on amateur astronomy throughout the English-speaking world by Admiral William Henry Smyth (1788-1865) and his *Cycle of Celestial Objects*, a book heavily drawn upon by later amateur handbooks such as Webb's *Celestial Objects for Common Telescopes* and Olcott's *Field Book of the Skies*. Nevertheless, the unusual history of Smyth and his book is insufficiently known.

Though Smyth was born in England, his ancestry was American, for his father was a loyalist emigré from New Jersey after our Revolution, and he himself was a direct descendant of Captain John Smith, of Virginia fame. Entering the Royal Navy as a boy, he managed by self-education and strength of character to rise from the ranks, an unusual accomplishment at that time. During the Napoleonic wars, he served in the Mediterranean, commanding a brig, making hydrographic surveys, and carrying out diplomatic missions.

These duties brought Smyth to Palermo in 1813, where he visited the observatory and met Giuseppe Piazzi, the discoverer of Ceres. The Sicilian astronomer deeply influenced Smyth, who now decided on an astronomical career, and even named his son Charles Piazzi Smyth.

Retiring from active service as a captain in 1825, Smyth settled at Bedford, England, where he erected an observatory, in which a fine 5.9-inch refractor by Tully was mounted in 1830. During the next nine years he measured several hundred double stars and examined many of the brighter nebulae and clusters. Afterwards the instrument was sold to his friend, Dr. John Lee, who built an observatory for it at Hartwell House.

These observations were published in 1844 as Smyth's *Celestial Cycle*. Its first volume is general in character; the double star, cluster, and nebula data are collected in the second volume, often known by its subtitle as the *Bedford Catalogue*. This work at once became popular, both as the first manual for the amateur observer and for its delightful style and wealth of curious historical lore.

In 1845, the Royal Astronomical Society awarded Admiral Smyth its gold medal for the *Bedford Catalogue*, and in the same year elected him president for a two-year term. His personal influence was great, for his jovial character won him a very wide circle of friends.

Fourteen years after Smyth died in 1865, the *Bedford Catalogue* became the center of bitter controversy. A number of cases had been reported of discrepancies between Smyth's descriptions of

Admiral W. H. Smyth, from the portrait belonging to the Royal Astronomical Society in London.

double stars and later observations. This led a hitherto little-known young English amateur, Herbert Sadler, to examine the catalogue in detail. He submitted his findings for publication in the *Monthly Notices* of the Royal Astronomical Society. Through accident the paper was not adequately examined by referees, so that its content was unknown until it appeared in print in the January, 1879, number.

The startled readers of this issue found an elaborate attack on Smyth's honesty, listing many cases where Sadler suggested that Smyth had copied double star measures by previous observers, instead of actually determining the position angles and distances himself. A single example will illustrate: The star Gamma Persei has a distant companion first measured by Sir John Herschel, who gave its position angle as 224°.9, which modern measures show to be a misprint for 324°.9. Nevertheless, the position angle is cited by Smyth as 226°.0 for the epoch 1837.6.

Sadler's enthusiastic attack gave deep offense to many. The surviving friends of the admiral bitterly and loudly resented the imputation of dishonesty, and the members of the Royal Astronomical Society were antagonized by the tactless criticism of the award in 1845 of the gold medal to Smyth. At a tumultuous meeting of the society, censure of the council was urged for having allowed the offending paper to be printed, and Sadler's resignation was demanded.

It was not until a year later, in 1880, that the true nature of Smyth's double star observations was finally clarified and the dispute settled. S. W. Burnham, already the leading American expert on double stars, in 1879-1880 re-examined the stars of the *Bedford Catalogue* with the 18½-inch refractor at Chicago (now at Dearborn Observatory). This revealed that Smyth's observations fell sharply into two classes: well-known, moderately close pairs for which Smyth's measurements were uniformly of fair quality; and wide pairs not measured by anyone before Smyth, for which his data were often grossly in error.

A satisfactory explanation of this was promptly given by E. B. Knobel's thorough study of Smyth's original records. First, for wider pairs Smyth often had merely roughly estimated position angles and distances, but unfortunately printed them in such a way that they could be mistaken for measurements. Next, many pairs had been measured with a double-image micrometer of unusual construction that did not fix the position angle uniquely, and Smyth was led to choose one of several possible values by comparison with data by earlier observers. In addition, Knobel found many arithmetical errors in Smyth's reductions.

The result was that Smyth's honesty was entirely vindicated, but his double star work lost its reputation for reliability. It is now also known that the unusual colors that Smyth ascribed to faint stars are in general fallacious—a point worth mention as they are sometimes quoted even today.

Despite its defects—many of which were removed in the 1881 second edition—Smyth's *Celestial Cycle* remains a classic that is still delightful reading for its quaint style and out-of-the-way information. It will long be a cloudy-night solace to the amateur observer—if he knows where to get a copy! J. A.

STARS WITH EMISSION-LINE SPECTRA

A catalogue and bibliography of emission-line stars of types later than *B* has been published by Dr. W. P. Bidelman, of Lick Observatory, as No. 7 of the *Astrophysical Journal* Supplement Series. There are 1,114 stars whose spectra have bright hydrogen lines, and 426 additional stars showing ionized calcium in emission; references to spectroscopic observations are given for each star. About two thirds of the objects listed are known variable stars.

Dr. Bidelman's contribution is a companion piece to similar listings of early-type stars with emission-line spectra published previously by Dr. Paul W. Merrill, of Mount Wilson and Palomar Observatories. The new catalogue, which is subdivided according to the variable star types represented, will prove very useful to workers in variable stars and general spectroscopy.

The Meaning of Betelgeuse

GEORGE A. DAVIS, JR.

The modern Orion, as depicted in Bayer's "Uranometria" of 1603, shows the hunter with Betelgeuse in his left shoulder and Rigel in his right foot.

PERHAPS no star name has boasted a greater variety of spellings, pronunciations, and meanings than the name we now use for α Orionis. I am not concerned with the spellings and pronunciations in this paper. The important problem which I should like to solve, if possible, is the derivation and meaning of the word Betelgeuse.

All agree that the last syllable of the name is from the Arabic noun *al-Jawza'*.* All scholars and students of Arabic also agree that "originally" the name was used to designate a black sheep with a white spot in the center of its body. And why is not that its meaning today, according to most of those same scholars? Because they took it upon themselves to decide gratuitously that the Arabs would not call the brilliant figure of Orion a sheep, but would give the group of stars the name of an abstract conception derived from a similar Arabic word, *jauz*, which means "the center of anything," and also a "walnut." Hence, it is said, the constellation was never known to the Arabs as a sheep, but as "the central one," because it was the middle figure of the sky.

It is true that the early Arabs conceived of certain abstract ideas by which they designated certain stars and asterisms, such as the "prop," the "neglected one," the "languid or flaccid one," the "faithful one," the "blazing one," and so forth. But such stars and groups of stars are not accompanied by members or parts of the body, such as arms, legs, and feet. They stand absolutely alone and self-sufficient. *Al-Jawza'*, however, does not fit into such a category. The Arabs, furthermore, would not have called the figure of Orion "the central one" because it did not lie on the ecliptic, which *was* regarded as the center of the sky. δ Geminorum, for example, was called *Wasat as-Sama'*, "the middle of the sky," because it lay practically on the ecliptic, and at some considerable distance from the equator.

We are not dealing here with an abstract conception, but with a very definite living creature, a sheep. "The white-belted sheep" was, therefore, in my judgment, the original name of our constellation among the ancient Arabs; but different tribes, as was natural, outlined the figure with different stars. Some, and perhaps they were the earliest to do so, saw the three stars in the belt as the figure of the sheep; others used the entire quadrilateral, as we shall see. This interpretation is supported by the following facts.

One of the names of α, and probably the oldest, was *Ra'i al-Jawza'*, "the shepherd of the white-belted sheep," and β was also given the same name. Another name for α was *Yad al-Jawza'*, "the forefoot of the white-belted sheep," and, in keeping with the same idea, β was called *Rijl al-Jawza'*, "the hindfoot" of the sheep. All these names, therefore, are perfectly consistent with the conception of a sheep representing the most brilliant constellation in the sky. The stars were exactly suited for the purpose, particularly δ, ε, and ζ, and the Arabs had no difficulty in seeing there an animal that was familiar to them—a sheep with a white marking on the center of its body.

This brings us to the first syllable of our name—"bet." It must be remembered that many of the letters in the Arabic alphabet are distinguished by diacritical points, either below or above the basic forms of the letters. The letters *ya* and *ba* for example, corresponding to our *y* and *b*, when beginning a word, have exactly the same form, but with *ya* having two points below and *ba* only one. A phenomenon which is familiar to students of Arabic is the loss of a point or the addition of one, which changes one letter into another, and which may give a word an entirely different meaning. This has occurred frequently in connection with star names with some ridiculous and fantastic results. Repeated transcriptions and transliterations over many centuries are two causes of this change.

I believe, therefore, on the available evidence, that the origin of our name is *Yad al-Jawza'*, "the forefoot of the white-belted sheep," one of the points having disappeared below the *ya* in *Yad*, resulting in the transliterated syllable *bad* or *bed*. The change of a *d* to a *t* needs no explanation. The meaning of Betelgeuse in my article in *Popular Astronomy*, 52, 23, 1944, should be corrected accordingly.

The name *al-Jabbar*, also given by the Arabs to our constellation, is late, and is simply their equivalent of the figure of Orion as described and portrayed in Greek mythology.

*It must be understood that the final *alif* in *al-Jawza'* is long wherever the word appears in this paper.

RING OF ELECTRICITY AROUND THE EARTH?

Indications that there is an external influence on the earth's magnetic field lead the British geophysicist, Dr. Sydney Chapman, to suggest that an invisible band of electrified matter may circle the earth at a height of some 12,000 to 16,000 miles. This equatorial band, if it exists, may be similar in shape to Saturn's rings. *Science News Letter* reports that radar waves of the proper wave length to detect such a ring would not penetrate the ionosphere, but radar carried above the ionosphere by high-altitude rockets might be used.

NEWS NOTES

By Dorrit Hoffleit

DIPLOMAT-ASTRONOMER DIES

Luis Enrique Erro, first director of the Tonanzintla Observatory, Mexico, died of a heart attack in January in his 58th year. Senor Erro had been a career diplomat and an ardent variable star observer. While a member of the Mexican embassy in this country during the late 1930's, he started plans for a Mexican national astrophysical observatory equipped with a large Schmidt-type telescope.

The Perkin-Elmer Corporation built the optical parts and the objective prism of the Tonanzintla Schmidt, and the driving mechanism was constructed at Harvard Observatory. This telescope, which has furthered international co-operation in astronomy since its inception, is a lasting monument to Senor Erro.

ASTRONOMICAL METHODS IN GEODESY

Two recent papers (in *Science* and in the *Transactions* of the American Geophysical Union) by W. A. Heiskanen, of Ohio State University, describe astronomical techniques used to determine the size and shape of the earth. The problem involves two surfaces. One is the reference ellipsoid, the basic surface for mapping, a purely geometrical configuration having the mean equatorial diameter of the earth and the same polar flattening as the earth. The other surface is the geoid, the actual equipotential surface of the earth. It is highly irregular in shape, but is the surface with respect to which all observations must be made. Gravimetric surveys are necessary to ascertain the differences between the two.

For determining distances on the geoid, classical and newer procedures have yielded highly accurate "yardsticks" over comparatively short distances. A major need is for precise transoceanic distances. Four celestial methods are available. One, promising but untried, involves photography of high-altitude rockets against star fields. In each of the other three, the moon serves as a triangulation point. One utilizes solar eclipses, another occultations, while the third is the moon-camera method with which Dr. William Markowitz, U. S. Naval Observatory, obtains accurate positions of the moon relative to background stars *(Sky and Telescope*, November, 1953, page 5).

Dr. Markowitz claims a precision of 40 to 50 meters in the distance of an observing station from the center of the earth. The method can be applied oftener and at more locations than either of the other two moon techniques. Hence, international co-operation has already been arranged among about 20 observatories for geodetic measurements with the Markowitz camera.

All of the methods using the moon yield high relative accuracy, but require knowledge of the equatorial diameter of the earth for the evaluation of actual distances, if measurements are limited to two stations only. The difficulty is overcome by observing at three stations, between two of which accurate surveys have been made. This distance then serves to calibrate the transoceanic measurements. Thus, during the June 30, 1954, eclipse, observations in Iran and Scandinavia were to provide the yardstick for the distance from Labrador to Scandinavia.

IN THE CURRENT JOURNALS

ASTRONOMICAL PHOTOGRAPHY — EQUIPMENT AND METHODS FOR THE AMATEUR, by E. H. Collinson, *Journal*, British Astronomical Association, December, 1954. "Astronomical photography is a fascinating pursuit which can be undertaken with quite simple equipment. In some fields results of scientific value can still be obtained by the amateur, but even if no such results are attempted or achieved he will derive much enjoyment from his work."

AGE OF THE EARTH, by C. Patterson, G. Tilton, and M. Inghram, *Science*, January 21, 1955. "The ore lead method for estimating an age uses terrestrial materials but gives rise to serious uncertainty in the determination of the age of the crust. The meteorite method uses a primordial lead of accurately known isotopic composition and gives an accurately determined age but makes use of extraterrestrial materials whose relationship to the earth is uncertain."

INFRARED MEASUREMENTS, PAST AND PRESENT, by Earle K. Plyler, *Journal*, Franklin Institute, January, 1955. "While the greatest interest is in the fields of chemistry in the analysis of compounds and the determination of molecular structure, many fields, such as physics, geology, biology, and astrophysics, have problems which can be solved by infrared techniques."

THE TIME-SCALE OF OUR UNIVERSE, by E. J. Opik, *Irish Astronomical Journal*, December, 1954. "Our knowledge of the present density of matter in the Universe is insufficient to decide between the two possibilities: that of open space, in which case the whole Universe is an irreversible process of temporal origin; and that of closed space, in which the Universe may return to its initial state, implying oscillations—the collapsing Universe rebounding from the elastic forces of the nuclear fluid at a state of maximum compression, to begin a new phase of expansion."

VELOCITY OF LIGHT

The National Bureau of Standards reports on two new determinations of the velocity of light, one by infrared radiation, the other by very-high-frequency radio waves. The two totally independent results agree closely. They confirm other postwar findings, mostly by microwave techniques, that the velocity of electromagnetic radiation is about 299,793 kilometers per second, rather than the 299,776 found from older measurements.

For the new determination by VHF radio, E. F. Florman set up equipment at a dry lake in Arizona where a five-mile stretch of very flat terrain was available. He worked at 172.8 megacycles per second to avoid sky-wave interference, to minimize ground effects, and to reduce the physical size of the measuring system. Over the precisely surveyed range, measurements were made of the phase shift between two receiving antennas 1,500 meters apart. This resulted in a value of 299,795 ±3 kilometers per second, the weighted average of 110 independent measurements made during 10 days.

E. K. Plyler, L. R. Blaine, and W. S. Connor measured molecular constants of carbon monoxide by infrared spectroscopy, following a method originally suggested by Dr. A. E. Douglas, of Ottawa. Laboratory measurements of wave length for the spectral lines were used to calculate the values of the molecular constants that occur in theoretical formulae. Values for the same constants were obtained in both infrared and microwave equations, but in different units, the infrared in reciprocal centimeters, the microwave in megacycles per second. The ratios of the corresponding constants then yielded the velocity of electromagnetic propagation, 299,792 ±6 kilometers per second.

FIREBALL OVER ALBERTA

From the Edmonton Centre of the Royal Astronomical Society of Canada, Ian C. McLennan and Franklin C. Loehde send statistics on the very bright fireball that was seen at 8:53 p.m. MST on December 19, 1954, by residents of the provinces of Alberta and Saskatchewan and the state of Montana. Before exploding, the fireball appeared brighter than the full moon.

Fifteen seconds after the phone number of the Edmonton Centre had been announced over Station CHED, phone calls poured in from all over the province, and continued to come in for four days. These reports are being followed up by personal interviews, but preliminary calculations indicate that the meteor was visible for 140 miles of its path, starting about 300 miles north-northeast of Edmonton. The extension of the path to the earth's surface, toward the south-southwest, ends near the Drumheller badlands, where a recovery may be possible.

Amateur Astronomers

APRIL REGIONAL CONVENTIONS

Southeast Region. Bradley Observatory at Agnes Scott College, Decatur, Ga., will be the site of the April 16-17 convention of the Southeast Region of the Astronomical League. Dr. Kenneth M. Yoss, of Louisiana State University, will be guest speaker. He will discuss "Stellar Populations I and II." Dr. Karel Hujer, University of Chattanooga, will talk on his trip to view the 1954 eclipse from Sweden.

The Atlanta Astronomy Club is host society. Anyone interested is invited to attend. Further information may be had from Mrs. John R. Peterson, 339 Forrest Blvd., Decatur, Ga.

C. H. HOLTON
Atlanta Astronomy Club

Northeast Region. On April 23-24, the Northeast Region of the Astronomical League will meet at Rensselaer Polytechnic Institute in Troy, N. Y., with the Rensselaer Astrophysical Society and the Troy Astronomy Club as hosts. Registration will begin at 8 o'clock Saturday morning in the lobby of Russell Sage Laboratory. The convention will be called to order at 9:30. After sessions during the day, there will be a banquet Saturday evening, and open house at the RPI observatory.

The registration fee of $1.00 and the banquet reservation, $3.00 per person, should be sent in advance, if possible, to the registration chairman, Peter S. Conti, 1932 Fifth Ave., Troy, N. Y. Titles of papers should be submitted to the program chairman, Patrick O'Shea, 45 Second Ave., Troy, N. Y. Papers should not exceed 10 minutes in length.

Sunday morning will be devoted to exhibits. A short description of proposed exhibits should be sent to the exhibits chairman, Jack DeBock, 317 Fifth Ave., Troy, N. Y.

Room reservations should be made direct with the Hendrick Hudson Hotel in Troy or at one of the numerous nearby motels.

STEPHEN W. CLOSE, JR.
Rensselaer Astrophysical Society

ASTRONOMICAL ACTIVITIES IN PHILADELPHIA

In March, the astronomy department of the Franklin Institute began a series of 10 lectures entitled, "Astronomy for Everyone." These are being given on Thursday evenings at 7:00 p.m. in the Fels Planetarium, and the speakers include Dr. I. M. Levitt, John W. Streeter, Edwin F. Bailey, and A. A. Faulkner.

For April and the first week of May, the lecture titles are: The Source of All Light, From Here to Eternity, Look at the Sun, Galaxies of Stars, The Exploration of the Universe. There is no admission charge to the individual lectures; a single registration fee of 50 cents for the entire course is collected at the door on the first evening of a person's attendance.

On April 22nd, Sir Harold Spencer Jones, Astronomer Royal of England, will be presented with the Rittenhouse medal at a joint meeting of the Rittenhouse Astronomical Society and the Franklin Institute.

THIS MONTH'S MEETINGS

Brooklyn, N. Y.: Brooklyn Institute of Arts and Sciences, 8:15 p.m., Academy of Music. April 22, Edward Lilley, Naval Research Laboratory, "Progress in Radio Astronomy."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. April 1, Dr. George C. McVittie, University of Illinois Observatory, "Why Should an Astronomer Study Relativity?"

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. April 25, Dr. B. Stroemgren, Yerkes Observatory, "The Formation and Evolution of the Stars," read by Jack Kucera.

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. April 12, William Siekman, "The Aurora Borealis."

Long Beach, Calif.: Excelsior Telescope Club. April 23, star party, Menifee Valley Observatory.

Minneapolis, Minn.: Minneapolis Astronomy Club, 7:30 p.m., Science Museum. April 6, Wensell S. Frantzich, "Spring and Summer Skies."

Montreal, P. Q.: Royal Astronomical Society of Canada, 8:15 p.m., McGill University. April 4, Charles M. Good, "Jupiter."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. April 6, William Herriott, "You Can Photograph the Stars."

Rutherford, N. J.: Rutherford Astronomical Society, 8:15 p.m., YMCA. April 7, A. Cox, "New Facts About Mars"; Fred Waite, "Engineering the Universe."

Sacramento, Calif.: Sacramento Valley Astronomical Society, 8 p.m., Sacramento Junior College. April 14, Dr. L. G. Henyey, Leuschner Observatory, "Stellar Evolution."

South Bend, Ind.: St. Joseph Valley Astronomers, 7:30 p.m., YMCA. April 7, O. R. Knab, demonstration, Spitz Jr. Planetarium.

St. Louis, Mo.: St. Louis Amateur Astronomical Society, 8 p.m., St. Louis Institute of Technology. April 15, Merlin Checkett, Station WTPB, "Radio Astronomy."

St. Paul, Minn.: St. Paul Telescope Club, 7:30 p.m., Macalester College. April 13, Dr. S. R. B. Cooke, "The Messier Objects." April 27, Dr. Sherman Schultz, movies and slides.

Teaneck, N. J.: Bergen County Astronomical Society, 8:30 p.m., Town Hall. April 13, Richard S. Luce, Amateur Astronomers Association, "The Amateur's First Telescope."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. April 2, Dr. Cecilia Payne-Gaposchkin, Harvard Observatory, "New Stars."

AAVSO SPRING MEETING

The American Association of Variable Star Observers will have its spring meeting at Pittsburgh, Pa., on Memorial Day weekend, May 27-29, 1955. Headquarters will be the Buhl Planetarium and Institute of Popular Science. Plans include a visit to Allegheny Observatory; instrument exhibits by J. W. Fecker, Inc., and the Amateur Astronomers Association of Pittsburgh; and a feature lecture by Dr. N. E. Wagman, director of Allegheny Observatory.

The meeting is open to the public, and nonmembers are invited to attend.

MARGARET W. MAYALL, Recorder
AAVSO, 4 Brattle St.
Cambridge 38, Mass.

NEW YORK AMATEURS MOVE HEADQUARTERS

On February 19th, the Amateur Astronomers Association moved its headquarters and administrative offices to 201 West 79th St., New York 24, N. Y. At present the classes, lecture meetings, and telescope making continue at the American Museum of Natural History, the society's former address.

THREE RIDDLES OF PLATO

(Continued from page 223)

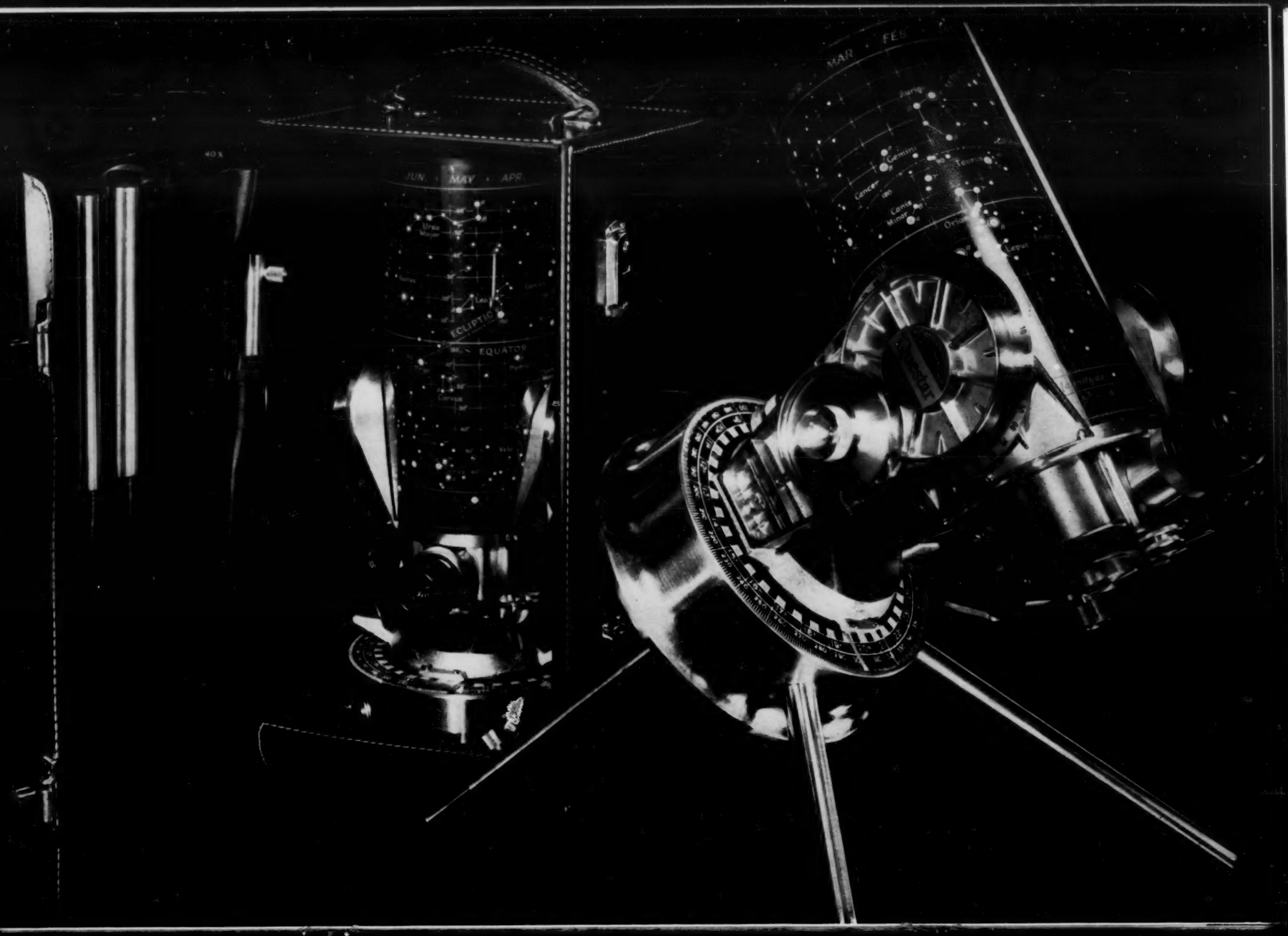
floor; in particular, Wilkins and Moore, in independent views, found no sign of a relatively prominent crater pit Dr. Wilkins knew to exist near the eastern landslip. A few hours later Thomas Cragg, observing at Mount Wilson, could see no detail at all over the entire floor of Plato.

"Is this not a certain indication of obscuration?" Dr. Wilkins asks. "When we observed, the eastern part must already have been covered by something which hid the craterlet and this spread over the floor by the time Cragg observed."

There are many similar records. Moore believes that the only satisfactory explanation is the occurrence of mists in the interior of Plato.

Here you have them—three riddles of Plato. There are other mysteries about this walled plain. Once you start looking, you'll discover some for yourself. Above all, draw what you see, both for your own enjoyment and for the benefit of other students of the moon. Keep notes of your observations, with comments and descriptions of what you see. Mark down your estimates of transparency and seeing, what magnification and telescope you used, the date, time, and place the observation was made. You won't be alone. In 13 out of 18 recent issues of *The Strolling Astronomer*, publication of the Association of Lunar and Planetary Observers, there were comments on and drawings of Plato, even though the society's program includes hundreds of other lunar and planetary features.

Plato is the springboard into selenography that scores of amateurs have used —without solving its riddles. Maybe you can.


JUN
MAY
APR
MAR
FEB
Ursa Major
Leo
ECLIPTIC
EQUATOR
Auriga
Gemini
Cancer
Taurus
Canis Minor
Orion
Lepus

☆Questar is a beautiful and compact 20th-century telescope of great power and versatility. Its long list of patented improvements, developed during 8 years of research, make Questar revolutionary in design and performance.

All Questar's advantages stem from the ultra-compactness of its unique design. For Questar literally frees the telescope from the 18th-century form into which it has been frozen, and lifts from the telescope the ancient burden of sheer bulk and weight that has made it so awkward to set up and use, and so difficult to carry and store.

Questar's superb new optical system embodies the first basic discovery in telescope optics for the last 200 years. It excels refractors of like aperture by the absolute absence of spurious color, and it is superior to reflectors by its spiderless closed tube construction and the perfection of its images over a wide field.

The photograph cannot show the deep blue jewel-like color of the engraved enamel-filled perpetual star chart, but it does indicate Questar's honest engine-turned aluminum and stainless steel.

In altazimuth form Questar travels as shown at the left, free-standing in its fitted case, fully assembled and always ready for instant use, in ½ cubic foot. With images normally erect, rotary eyepiece, and built-in car attachment, and power-is the most versatile, convenient, and powerful terrestrial viewing scope of all time. It is a perfect 42-inch telephoto lens. With internal focusing to as near as 7 feet, it is the world's first long-distance microscope, a previously unknown and thrilling instrument.

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BOOKS AND THE SKY

TIME COUNTS

Harold Watkins. Philosophical Library, New York, 1954. 274 pages. $4.75.

A GLIMPSE at the weights and measures used by peoples throughout the world reveals a bewildering complexity and diversity. For example, in the English system we have 12 inches in a foot, three feet in a yard, 5½ yards in a rod, 40 rods in a furlong, eight furlongs in a mile, and three miles in a league. In the USSR an *arshine* is 28 inches, in Japan a *bu* is 0.12 inch, in Denmark a *mil* is 4.60 miles, and so on and so forth. The science of metrology is indeed involved.

The origins of many of these measures are bound up with the histories of the nations using them, and often they exhibit an eccentric caprice that has been perpetuated by common usage. While the human body has been the basis for many of the linear units still in use (foot, palm, hand, pace, ell), it remained for King Henry VII to imprint his bodily dimensions on the English-speaking world in the inch, foot, and yard. In much the same way, man's common accounting of time has been dominated by the whims of conquerors, as well as ecclesiastical and political leaders, from the beginnings of the calendar to the present.

Time Counts is a readable history of the origins of calendars, and a report on recent calendar reform movements. To those who have not been introduced to the vagaries of the history of our calendar, the book is fascinating reading. To those already familiar, it gives an up-to-date record of attempted legislation in individual countries and the United Nations.

After a description of the earliest calendars, we are led through the maze of the system initiated by Julius Caesar. While nearly everyone has heard about the kalends, nones, and ides, few know the intricate enumeration of the days of the month by the Romans.

About A.D. 525 Dionysius Exiguus introduced the supposed birth year of Jesus Christ as the beginning of the Christian era, calling it A.D. 1. Actually, scholars are now convinced that the nativity of Christ took place between 8 B.C. and 4 B.C., so that Dionysius made an error in the beginning of the era. Moreover, no year called 0 was allowed for, because Dionysius used Roman numerals, which have no zero.

Two hundred years later, the Venerable Bede noticed that the equinoxes were arriving three days earlier than they had at the time of the Council of Nicaea in A.D. 325. This was because the tropical year adopted by Julius Caesar was 11 minutes and 14 seconds too long, causing the Julian calendar to accumulate one day every 128 years. For many years thereafter, learned ecclesiastics and scholars saw the need of reforming the calendar so that it could be in exact step with the seasons. Finally Pope Gregory XIII, under the advice of the astronomer Luigi Lilio, decreed the well-known reforms in the Julian calendar, beginning with the year 1582.

Necessarily, Roman Catholic countries adopted these measures, while Protestant and Eastern Orthodox countries did not. In Britain it took the concerted efforts of men like Lord Chesterfield, Lord Macclesfield, and James Bradley, then Astronomer Royal, to convince their countrymen of the benefits of the Gregorian calendar over the Julian. That their task was laborious is brought out by Lord Chesterfield's comment on his speech before the House of Lords: "For my own part, I could just as soon have talked Celtic or Sclavonian to them as astronomy, and they would have understood me full as well. . . . " But the goal was accomplished in 1752, when the English calendar was brought in line with the Gregorian.

Sweden made the transition to the Gregorian calendar smoothly, without the great disruption experienced elsewhere. This was done by omitting leap year days until enough had been dropped to bring the calendar into agreement.

We next read about the radical but ingenious calendar of the French Revolution, devised by Laplace, Monge, and Lagrange. Months of 30 days each were divided into three decades, thus doing away with the seven-day week. Furthermore, the day was divided into 10 equal parts (equal to 2.4 of our hours), each of their "hours" into 100 "minutes," and each "minute" into 100 "seconds." There were therefore 100,000 "seconds" and 1,000 "minutes" in the day, as compared with our 86,400 mean solar seconds and 1,440 minutes. The great experiment lasted 13 years until Napoleon restored the Gregorian calendar on January 1, 1806.

The greater part of the book is devoted to the attempts of various institutions and individuals, on the national and international levels, to bring about reform in the Gregorian calendar. In the present century two well-known systems have been the leading contenders: the 13-month perpetual (or fixed) calendar and the World Calendar. In more recent years the World Calendar has seemingly gained the ascendance. By now, most nations recognize the convenience, utility, and money-saving quality of the proposed calendar, but nearly all have suffered from an all-too-human inertia, or have felt like Harry S. Truman, who said that he had "never given the matter serious thought or study because it would take a Pope Gregory the Great or a Julius Caesar to put these changes into effect."

Although the United Nations turned down calendar reform in 1949, the number of nations actively supporting the World Calendar is increasing, and there will be another vigorous attempt in 1955 (and again in 1959 if the former fails) to have the United Nations pass on the proposals that would set in motion world changes in the calendar.

Time Counts is well written and engaging. An occasional factual error (on page 5 the author refers to light-years and parsecs as units of time) or misty explanation (as on page 7, concerning the sun) does not seriously detract from the material. Perhaps the only matter in the book unacceptable to most scientists is

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THE WINTER STARS HAVE SET

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the cosmological theory of Hoerdiger and his followers, who maintained that some 300,000 years ago a second, smaller moon circled the earth. As it slowly spiraled toward earth, it supposedly raised huge tides and eventually disintegrated. One wishes the author had taken a more positive stand against this Velikovskian hypothesis.

MORRIS S. DAVIS
University of North Carolina

TRANSACTIONS OF THE INTERNATIONAL ASTRONOMICAL UNION

Volume VIII, 1952

P. Th. Oosterhoff, editor. Cambridge University Press, New York, 1954. 887 pages. $10.50.

THE EIGHTH general assembly of the IAU was held at Rome in September, 1952. This volume is a record of that event, but actually it gives a full summary of astronomical activity throughout the world in the four years preceding. It contains the reports of 38 commissions, each summarizing work done and current problems in as many different aspects of astronomy. All professional astronomers know the *Transactions* as a valuable reference work, but there are many others such as advanced amateurs and teachers who can find it useful.

It is the place to turn to when the question comes up of what is new in the field of minor planets, or what plans there are for a new general catalogue of visual double stars, or of the present extent of international co-operation in astronomy. Specially noteworthy are the 200 pages of papers presented at the four Rome symposia, on stellar evolution, astronomical instrumentation, astrometry of faint stars, and spectra of variable stars. Among these papers, Dr. I. S. Bowen's technical description of the 200-inch Hale reflector should be of wide general interest.

A matter of particular concern to the amateur astronomer is the propriety of the new names assigned to some lunar formations by Dr. H. Percy Wilkins, director of the lunar section of the British Astronomical Association. For instance, he recently proposed that the names Gant, Watts, and F. E. Wright be used for craters now called Archimedes A, Kastner A, and Licetus F.

Commission 16, dealing with physical observations of planets and satellites, under the chairmanship of Dr. G. P. Kuiper, has jurisdiction over the naming of lunar formations. On page 216 of these *Transactions*, in the report of Commission 16, we find:

"Two proposals had come before this Commission, one by M. Wilkins who wished to reopen the discussion of lunar nomenclature; and one by M. Fournier who wished to recommend a simplified nomenclature for Martian surface detail. Both questions had been discussed at Zurich (*Trans. I.A.U. 7*, pp. 166-7). With respect to the moon the Commission reaffirmed its 1948 decision; it was agreed unanimously to adhere to the nomenclature developed by Miss Blagg and M. Muller, without change. . . ."

The handsome appearance of the book and its freedom from misprints do credit to both Dr. Oosterhoff and the Cambridge University Press. However, a book of nearly 900 pages on heavy paper is so thick that it must be carefully handled to avoid breaking its back. If future volumes of the series were printed on thinner paper, they would be handier and less liable to damage. J. A.

THE MICROPHYSICAL WORLD

William Wilson, Philosophical Library, New York, 1954. 216 pages. $3.75.

IT HAS BEEN SAID that man stands halfway between the atom and the star. Scientifically, this statement describes our place on the scale of size from a single atom to a star; philosophically, it indicates that we are in a position to look either way: to the world of the very large, the macrocosm, or the world of the very small, the microcosm.

The readers of this magazine are used to looking out into the macrocosm, into the vastness of the universe. Many, perhaps, have not peered as intently at the equally vast microcosm, the world of the atoms. For the latter, this book can serve a real purpose.

As an amateur astronomer, I found it interesting to read that there are on the order of 10^{11} stars in a galaxy and 10^{11} galaxies in the universe, that a star may weigh 2×10^{27} tons and that the universe may weigh 2×10^{49} tons. In terms of the microcosm, there are about 10^{24} protons in a gram and 10^{79} protons

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in the universe. These figures show how futile it is to try to comprehend the actual quantities stated. To this layman's mind, 10^{79} seems only somewhat bigger than 10^{24}, yet the difference represents the range in numbers from a small sample of matter to the content of the entire universe.

Written for the intelligent layman, the book demands some background in physics and chemistry. There are chapters that deal with the men and work of Dalton's day, atoms and molecules from the point of view of physics and chemistry, spectra and light, cathode rays, X-rays and electrons, radiant heat and the quantum theory. Other chapters give details about the hydrogen atom, the helium atom, electron orbits, and the inside of the atomic nucleus. Hardly anything of basic significance seems to have been left out.

Brief and to the point, the more than 200 pages of text are crammed full of material without seeming to be crowded. It is not, however, a bedside book, and the intelligent reader may find it somewhat of a challenge. It is called a book without mathematics, but there are plenty of formulae and mathematical data to which a reader with ability can apply himself. Yet the nonmathematical person can get the meaning without the math.

Wilson is aware of the persistent question laymen ask concerning scientific knowledge: "How do scientists know these things?" His work is logically organized to present the history of man's search for truth about the atom. Yet he leaves us with the very appropriate feeling that we get nearer and nearer to the truth but never finally reach it.

We live in a tremendous universe, in a world that is at once macrophysical and microphysical. Books like Wilson's lead us along the endless road toward understanding the nature of this world even though we must look elsewhere to seek its meaning.

JOHN STERNIG
Assistant Superintendent
of Schools
Glencoe, Ill.

NEW BOOKS RECEIVED

PHYSICS OF THE PLANET MARS, *Gerard de Vaucouleurs,* 1954, *Macmillan.* 365 pages. $10.00.

This is a revision of the same writer's *Physique de la Planète Mars,* which appeared in 1951, translated by the author. He summarizes and analyzes recent findings concerning the atmosphere, surface, and interior of this planet, from the viewpoints of meteorology and physics.

STATISTIK UND PHYSIK DER KOMETEN, *Nikolaus B. Richter,* 1954, *J. A. Barth,* Salomonstr. 18 B, Leipzig C 1. 142 pages. DM 13.40, paper bound.

Dr. Richter, of the Sonneberg Observatory, is a specialist on comets who has now written a monograph, in German, covering nearly every phase of modern studies of these objects. Comet orbits are dealt with comparatively briefly; the main emphasis is on physical conditions and processes in cometary nuclei, comae, and tails. The conclusion is

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By Allyn J. Thompson. This book gives step-by-step instructions on how to construct a low-cost 6-inch reflecting telescope. It is designed for any enterprising hobbyist with the time, patience, and some mechanical ingenuity. 211 pages, 98 figures and 6 plates, **$4.00**

ATLAS OF THE HEAVENS

By A. Becvar and others at the Skalnate Pleso Observatory. This is a set of 16 charts, each 16 by 24 inches, and covers both hemispheres of the sky to stellar magnitude 7.75, showing double, multiple and variable stars, novae, clusters, globulars and planetaries, bright and dark nebulae, the Milky Way and constellation boundaries, galaxies. **$6.00**

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reached that the nucleus of a typical comet is a swarm of meteoric and ice particles, in contrast to Whipple's icy conglomerate model. Considerable attention is devoted to brightness changes in comets; theories of comet origins are summarized. There are numerous illustrations, an appendix of tabular data, and a bibliography of 192 items.

ART IN SCIENCE, 1954, *Simon and Schuster*. 32 plates in portfolio. $6.00.

This collection contains 32 reproductions of paintings, photographs, and drawings, mostly in color, that have appeared as illustrations in *Scientific American* from 1948 to 1954. The subjects range from oceanographic instruments to cave paintings of bison by prehistoric man, and from radio telescopes and electronic computers to the death of a tarantula. Each 12¾ by 11 inches, these pictures are on heavy paper, suitable for framing.

OPTICAL WORKSHOP PRINCIPLES, *Charles Dévé*, 2nd edition, 1954, *Hilger and Watts*, 98 St. Pancras Way, Camden Road, London N. W. 1. 436 pages. 42s.

This is an English translation of a standard French work on optical workshop practices. It explains the principles and uses of grinding machines, the polishing and testing of optical surfaces, making spectacle lenses, prisms, and polarizers, and many other matters of interest to the practical optical worker.

ONE HUNDRED MATHEMATICAL CURIOSITIES, *William R. Ransom*, 1955, *J. Weston Walch*, Box 1075, Portland, Me. 212 pages. $3.00, paper bound.

A Tufts College emeritus professor has collected puzzles and curiosa for the amateur who likes to play with numbers and geometrical figures. These range from telling time by the stars to Gauss' construction with compass and straightedge of a 17-sided regular polygon. Full discussions and solutions are given.

METEOR ASTRONOMY, *A. C. B. Lovell*, 1955, *Oxford University Press*, New York. 463 pages. $9.60.

This is a comprehensive summary of the astronomical aspects of meteors, written for the specialist. According to the preface, matters of meteor physics are to be dealt with in a later volume. Radio, photographic, and visual techniques of observation are examined, and their results discussed.

THE EARTH AS A PLANET, *Gerard P. Kuiper*, editor, 1954, *University of Chicago Press*. 751 pages. $12.50.

This is the second book in a four-volume series, The Solar System, appearing under the editorship of Dr. Kuiper. Sixteen authorities have contributed chapters on the dynamics of the earth, its interior and crust, oceanography, geochemistry, various aspects of the atmosphere, and the earth as observed from space.

ASTRONOMY, *John C. Duncan*, 5th edition, 1955, *Harper*. 500 pages. $5.50.

This is the fifth edition of a well-known college textbook that first appeared in 1926. The author states in the preface: "In this edition the effort has been to bring the book up to date without changing its form or size. Noted are such matters as the recent discoveries of satellites, the rapid rise of radio astronomy, the recognition of two types of stellar population, and the revision of the earlier accepted scale of the distances of external galaxies."

VARIABLE STARS AND GALACTIC STRUCTURE, *Cecilia Payne-Gaposchkin*, 1955, *Athlone Press*, London. 116 pages. $3.50.

Dr. Gaposchkin is Phillips astronomer at Harvard University, and her book is based upon her lectures at the University of London in 1952. She summarizes the basic observational data on all types of intrinsically variable stars, and applies this information to a study of the dimensions and structure of the Milky Way system.

THE SOURCES OF EDDINGTON'S PHILOSOPHY, *Herbert Dingle*, 1954, *Cambridge University Press*. 64 pages. 75¢, paper bound.

The foundations of Eddington's views on relativity, physics, and cosmogony are examined by a prominent British historian of science. This volume is the text of the eighth Eddington memorial lecture, given on November 2, 1954.

Planetarium Notes

(Most planetariums give group and special showings by appointment.)

BALTIMORE: *Davis Planetarium*. Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 3:45 p.m. Monday and Friday (Sept.-June); Thursday, 7:15, 7:45, 9:00 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BUFFALO: *Buffalo Museum of Science Planetarium*. Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sunday, 2:00 to 4:30 p.m. Admission free. Spitz projector.

CHAPEL HILL: *Morehead Planetarium*. Univ. of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; also 11 a.m. and 3 p.m. Saturdays, 3 and 4 p.m. Sundays. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium*. Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11:15 a.m. Admission free. Spitz projector. Director, Louise L. Morlang.

CHEROKEE, IA.: *Sanford Museum Planetarium*. Sanford Museum, 117 E. Willow St., Cherokee, Ia.

SCHEDULE: Monday, 8 p.m. (except August). Admission free. Spitz projector. Director, W. D. Frankforter.

CHICAGO: *Adler Planetarium*. 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 2-1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Tuesdays and Fridays, 8 p.m.; Sundays, 2 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

INDIANAPOLIS: *Holcomb Planetarium*. Butler University, Indianapolis 7, Ind.

SCHEDULE: Wednesday, 3:30 p.m.; Saturday, 3:30, 8, and 9 p.m.; Sunday, 3:30, 4:30, 8, and 9 p.m. Spitz projector. Director, Harry E. Crull.

KANSAS CITY: *Kansas City Museum Planetarium*. 3218 Gladstone Blvd., Kansas City 23, Mo., Humboldt 8000.

SCHEDULE: Saturday, 3:00 p.m.; 2nd and 3rd Sundays, 3:00 and 4:30 p.m. Spitz projector. Director, Kenneth W. Prescott.

LOS ANGELES: *Griffith Observatory and Planetarium*. Griffith Park, P. O. Box 27787, Los Feliz Station, Los Angeles 27, Calif., Normandy 4-1191.

SCHEDULE: Wednesday, Thursday, and Friday at 8:30 p.m.; Saturday and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

MINNEAPOLIS: *Science Museum*. Minneapolis Public Library, 1001 Hennepin Ave., Minneapolis 3, Minn.

SCHEDULE: Tuesday, 7:30 p.m.; Saturday, 10 a.m. and 2 p.m. Admission free. Spitz projector. Curator of education, Maxine L. Begin.

NASHVILLE: *Sudekum Planetarium*. Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., 42-1858.

SCHEDULE: Sunday, 2:45, 3:30, 4:15. Spitz projector. Associate curator of education, Burton Ingram.

NEWARK: *Newark Museum Planetarium*. 49 Washington St., Newark 1, N. J., Mitchell 2-0011.

SCHEDULE: Saturday and Sunday, 2:30 and 3:30 p.m. Admission free. Spitz projector. In charge, Ray Stein.

NEW YORK CITY: *American Museum—Hayden Planetarium*. 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 1, 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 1, 2, 3, 4, 5, and 8:30 p.m.; Mondays, Wednesdays, Thursdays and Fridays, 11 a.m., for school groups. Zeiss projector. General manager, J. M. Chamberlain.

PHILADELPHIA: *Fels Planetarium*. Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science*. Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 1-4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 4:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium*. 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

SCHEDULE: Saturday and Sunday, 3:00 p.m. Spitz projector. Director, Stanley H. Shirk.

PROVIDENCE: *Roger Williams Planetarium*. Roger Williams Park Museum, Providence 5, R. I., Williams 1-5640.

SCHEDULE: Saturdays, Sundays, and holidays, 3 and 4 p.m. Admission free. Spitz projector. Director, Maribelle Cormack.

SAN FRANCISCO: *Morrison Planetarium*. California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday) at 3:30 and 8:15 p.m.; also at 2 p.m. on Saturdays, Sundays, and holidays. Academy projector. Curator, George W. Bunton.

SPRINGFIELD, MASS.: *Seymour Planetarium*. Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8:30 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, F. Korkosz.

STAMFORD: *Stamford Museum Planetarium*. Courtland Park, Stamford, Conn.

SCHEDULE: Sunday at 4:00 p.m. Admission free. Spitz projector. Director, Ernest T. Luhde.

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54 mm (2⅛")	330 mm (13".....	**12.50**	83 mm (3¼")	711 mm (28".....	**28.00**
54 mm (2⅛")	390 mm (15.356")..	**9.75**	83 mm (3¼")	762 mm (30".....	**28.00**
54 mm (2⅛")	508 mm (20".....	**12.50**	83 mm (3¼")	876 mm (34½"...	**28.00**
54 mm (2⅛")	600 mm (23½"...	**12.50**	83 mm (3¼")	1016 mm (40".....	**30.00**
78 mm (3 1/16")	381 mm (15".....	**21.00**	110 mm (4⅜")*	1069 mm (42 1/16")	**60.00**
81 mm (3 3/16")	622 mm (24½"...	**22.50**	110 mm (4⅜")	1069 mm (42 1/16")	**67.00**

*Not coated

● We can supply ALUMINUM TUBING for the above lenses. ●

3X ELBOW TELESCOPE

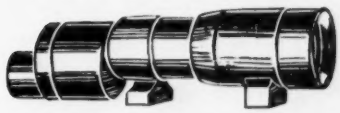
Makes a nice low-priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, and light weight, 2 lbs. Gov't. Cost $200.

Plain Optics . **$9.75** Coated Optics . **$12.50**

FIRST SURFACE MIRRORS

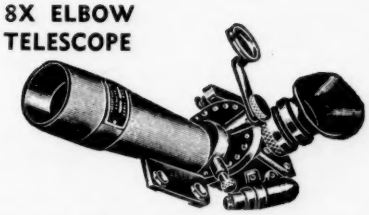
Size	Thickness	Postpaid
14" x 16"	¼"	**$10.00**
8" x 10"	¼"	**4.25**
4" x 5"	¼"	**1.85**
4" x 4"	¼"	**1.50**
1¼" x 1½"	1/16"	**.25**

SMALL SPECIALIZED TELESCOPE



1½ power, 5½ inches long, solid brass construction, weight approximately 1 lb. Contains an objective lens, mounted Porro-Abbe erecting system and an achromatic eyepiece which was designed for good eye relief. Eye distance 4" **$4.50**

8X ELBOW TELESCOPE



This telescope will make an exceptional finder. Objective 52 mm diameter. Focusing eyepiece, turret-mounted filters, amber, red, neutral, and clear. Illuminated cross-line reticle, quick-finding level sight, and large-size Amici prism.

Used.... **$18.50** Brand New.... **$27.50**

OPTICAL PEEP SIGHT

Use as a camera view finder and for similar purposes. The image appears on a bull's-eye reticle. There is no parallax for any distance. The same principle is commercially used by shotgun-sight manufacturers. The diameter is 37 mm. Weight 1½ oz. Gov't. cost $10.75.

Our price.....**Postpaid $1.00**

LENS CLEANING TISSUE—Here is a wonderful Gov't. Surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications. 500 sheets size 7½" x 11"..... **$1.00**

"GIANT" WIDE-ANGLE EYEPIECE

Known among amateurs as the "Giant Jaegers," this is the finest wide-angle eyepiece ever made. It gives a flat field. It is mounted in a focusing cell. This is an Erfle eyepiece, 1½" effective focal length, with a clear aperture of 2 3/16". It may be used as a Kodachrome viewer, magnifying seven times.

$125.00 Value..... **$18.50**

BRAND NEW COATED 1¼" E.F.L. wide-angle eyepiece. Contains 3 perfect achromats. Aperture is 1 3/16". (Illustrated) **$13.50**

"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE—C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 10 days

7 x 50 MONOCULAR

Of the same high quality as our binoculars. Many observers find them ideal as rich-field sky sweepers or as telescope finders. Brand new, coated optics, complete with genuine leather plush-lined carrying case and straps. 7 power; objective is 50 mm in diameter.

$17.50

AN ECONOMICAL EYEPIECE

This mounted eyepiece has two perfect fluoride coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x). The eyepiece cell fits a 1¼" tube.... **$4.50**

6X BATTERY-COMMANDER PERISCOPE

Made of brass. Has focusing eyepiece and crossline reticle. Weight 3½ lbs., length 28".

Postpaid **$15.00**

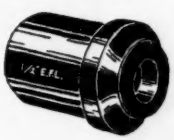
Geared mount and sturdy tripod for the above are available. Write for the low price.

40-POWER TELESCOPE With Tripod

For stargazing and terrestrial use. It gives an upright image. Large coated achromatic objective 60-mm diameter. Tripod constructed of wood with brass extension tubes. Tube 22" when closed, 56" fully extended. Swivel mount can be locked in any position. **$39.75**

MOUNTED EYEPIECES

SUPERIOR QUALITY SUPERIOR WORKMANSHIP THEY CAN'T BE BEAT!



We have a large stock of precision war surplus lenses, and have mounted them in precision mounts of 1¼" outside diameter, the standard for telescopes. Result! You would pay several times more elsewhere. Our prices can't be beat.

12.5 mm (½") F.L. symmetrical eyepiece contains two cemented achromats.
Coated lenses **$6.75** Not coated **$6.00**

16 mm (⅝") F.L. extra wide angle Erfle contains five lenses.
Coated lenses **$13.50** Not coated **$12.50**

16 mm (⅝") F.L. triplet eyepiece contains a three-element lens and a simple lens.
Coated lenses **$13.50** Not coated **$12.50**

18 mm (¾") F.L. symmetrical eyepiece contains two cemented achromats.
Coated lenses **$6.75** Not coated **$6.00**

22 mm (27/32") F.L. Kellner eyepiece contains cemented achromat and a non-achromatic lens.
Coated lenses **$6.75** Not coated **$6.00**

32 mm (1¼") F.L. eyepiece contains two achromatic lenses.
Coated lenses **$13.50** Not coated **$12.50**

35 mm (1⅜") F.L. symmetrical eyepiece contains two cemented achromats.
Coated lenses **$8.75** Not coated **$8.00**

55 mm (2 3/16") F.L. Kellner eyepiece contains achromatic field lens and a non-achromatic eye lens.
Coated lenses **$6.75** Not coated **$6.00**

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Optical Instruments including standard Telescopes and all accessories.

First surface flat mirrors of pyrex or crown glass, figured within 1/8 wave tolerance. Uncoated. Thickness about 1/6 diameter. 4½" diam., **$40**; 6", **$65**; 8", **$110**. Larger diameters available.

Parabolic mirrors. Uncoated and hand corrected. Ratio, f/8. 4" diam., **$42.50**; 6", **$58**; 8", **$105.** Other diameters and focal lengths available.

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Plainfield, New Jersey

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KITS: Complete with instructions, high quality materials, supplied at low prices.

Plate—$4.50 up Pyrex—$5.75 up

MIRROR CELLS

Made of light, sturdy aluminum, they furnish an ideal method of securing the mirror to the tube. They are spring adjusted to absorb shocks and cut away for ventilation.
6"-$7.00 8"-$11.50
10"-$35.00

EYEPIECE ATTACHMENT WITH RACK AND PINION

Takes standard 1¼" O.D. eyepieces. Rack and pinion smoothly machined from solid aluminum castings. Precisely fitted for smooth performance. Main tube is 1¼" long; sliding tube adds 2"; total movement 3¼". Your choice of gray or black crinkle finish. $15.50

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Aluminizing—with the new Quartz Coating
Satisfaction Guaranteed
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GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A Second Telescope

FIRST MOUNTINGS rarely survive for long. Mine was made at a kitchen-table workbench, through the tolerance of a dubious but understanding wife. It served admirably for two seasons, proving to me that clusters and nebulae were available not only to Palomar but to a humble 5-inch reflector.

Dissatisfaction began on reading O. M. Erpenstein's article, "Mountings of Today and Yesterday," in the November, 1952, *Sky and Telescope*. I found my product was mongrel—a cross between a modern yoke and Herschel's cantilever altazimuth. It was an equatorial, but counterbalancing with springs has disadvantages.

My second mounting is a more conventional German-type equatorial, costing less than $25. The original 5-inch mirror was carried over, after refiguring. Construction was greatly simplified by using four 1" cast-iron pillow blocks, from the Boston Gear Works, for polar and declination bearings. Other metal materials included 3' of structural aluminum channel and 4' of 1" aluminum shafting.

After cutting the channel into two equal lengths, the bearings were bolted to either end. Inside the web of the declination channel I secured an oak block 2¼" thick. The polar-axis shaft was driven tightly into a 1" hole drilled in this block. The tube-carrying cradle was similarly attached to the declination axis.

The only machine work was boring and tapping the ends of the declination and polar shafts to a depth of 2" to accommodate 1½" lengths of ¼" threaded drill rod. Each stud carries a 2" 48-pitch 100-tooth Boston worm gear for the slow motions. The worms are mounted on the pillow blocks in short pieces of brass channel. The worm shafts have flexible extensions of speedometer cable so the observer can operate the slow motions without leaving the eyepiece.

Each of the slow motions has a simple but effective clutch. A washer cut from heavy gasket material is seated between the face of the worm gear and the end of the shaft. The shaft end is roughened with radial grooves cut 1/32" deep with a hacksaw. Thus, tightening the threaded stud, to which a radio knob has been fastened, will engage the worm gear with the shaft.

The pier is a 4" by 6" post set in the ground. On top of this a pedestal plate, cut from a 2" by 12" plank, is fastened by a single lag screw, so it can be turned for adjustment in azimuth. A radial slot cut in the pedestal plate accommodates a carriage bolt, which serves to lock the plate to the post at the proper azimuth. Leveling is accomplished by thumb screws on four carriage bolts extending through the base of the polar-axis mounting and the pedestal

A closeup of the equatorial mounting of the 5-inch telescope by W. Marshall Black, of Houston, Tex. Each slow motion consists of a 100-tooth gear and worm at the end of each shaft. The clutch mechanism is operated by the radio knobs that appear dark in this picture.

SKY-SCOPE
COMPLETE AS ILLUSTRATED $29.75

The full 3½-inch diameter reflecting type astronomical telescope that even the telescope makers talk about.

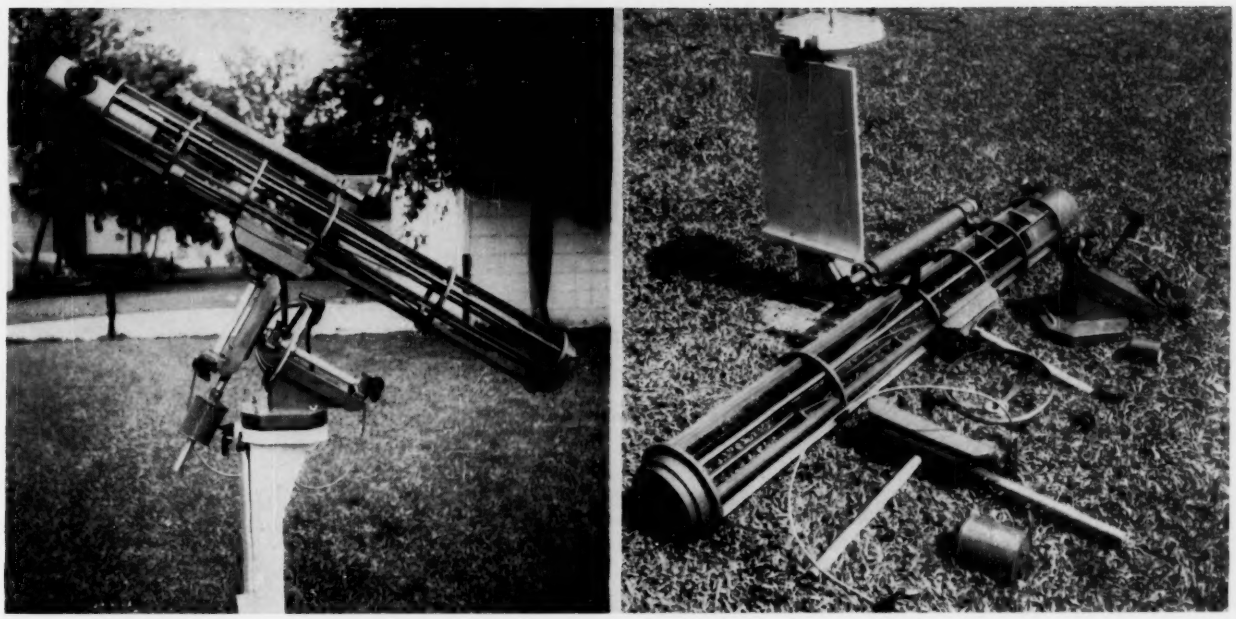
It has been sold for more than 15 years and now is on display in at least two U. S. planetaria. It will show mountains and craters on the moon, Saturn's rings, Jupiter's four moons and the planet's markings, and close double stars with guaranteed observatory clearness. Skyscope enjoys worldwide distribution.

Every instrument, with its ¼-wave, aluminized mirror, is individually tested before being packed for shipment. We suggest that before buying you inquire at almost any local astronomy society about the efficiency of Skyscope.

We invite your attention to our free and straightforward descriptive brochure which also shows a photograph of the individual parts used.

125-power and 35-power extra eyepieces ..... $5.15 each
Six-power finder, with brackets $7.50
Holder for extra eyepieces $1.00

THE SKYSCOPE CO., INC. 475-s Fifth Avenue, New York 17, N. Y.



Two views of the Black telescope show it at the left ready for observing, and at the right dismantled for transportation. The latitude adjustment head is one of the portable pieces.

plate. Base and plate are separated by compression springs slipped over the carriage bolts.

The tube is of skeleton construction. Six identical plywood rings, ½" thick, were turned together on a lathe, and then notched internally to take eight ½" by ¾" parting strips of hard pine which serve as stringers. The eyepiece draw tube and the diagonal prism are mounted in a length of 6" aluminum tube salvaged from scrap. This assembly turns within the skeleton tube to permit comfortable access to the eyepiece.

The counterweight shaft is mounted into a hole drilled in the end of the oak block that serves to secure the declination axis to the polar axis.

The 12" hour circle was built from the compass bowl of a war-wrecked German bomber. It is mounted free between the thrust bearing and the declination-axis oak block. For the declination circle (added after the photographs were made), a contact blueprint of a draftsman's 360° protractor was cemented to a 12" disk of masonite. However, I have not found circles essential, if star charts are at hand.

The entire mounting has proved adequate and steady, and it should survive for several seasons longer than my first.

W. MARSHALL BLACK
2611 Norfolk
Houston, Tex.

A HINT FOR TELESCOPE USERS

Dew Between Lens Components. On refractors a long dewcap is standard equipment to prevent dew from forming on the front surface of the objective, but it is worthwhile also to provide against dewing between the two components of the lens. I have found a simple means of accomplishing this.

First, put the objective, in its cell, in a warm place for sufficient time so that the air space between the elements is thoroughly dry. Melt a little beeswax in a small tin jar cover until it nearly boils. Then, with a small artist's brush, apply the wax to the edge of the objective where it enters the cell, front and back, sealing the lips of the cell to the objective, on both sides of the cell. The beeswax cools too quickly on the brush to put on more than an inch at a time, but this

REFIGURING

4¼"	Diam.	$14
6"	"	19
8"	"	30
10"	"	45
12½"	"	65

Refiguring includes polishing your mirror fully and figuring to a ⅛-wave parabola. Send tool with mirror for early delivery. Price includes aluminizing.

LOW-EXPANSION ELLIPTICAL DIAGONALS

Minor Axis	
¾"	$3.75
1"	3.75
1¼"	5.00
1½"	6.50

High quality, made of low-expansion glass, flat to ⅛ wave or better. Edges accurately ground to a perfect ellipse. Try using a smaller diagonal than you already have and watch the contrast, clarity, and sharpness of your image improve.

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½", ¾", & 1¼" focal lengths
$5.50 each. $14.00 per set

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Real Quality at an Unbelievable Low Price

MAKES A WONDERFUL 3" REFRACTOR

ONLY $28.00 ppd.

3 1/8" diameter, with 45" focal length. These were tested in the field by Hal Metzger, famed amateur, and pronounced "equal to any 3" objective made anywhere today, even at two or three times the price". Letter is in our files. This is an air-spaced achromat. The air-spacing of a lens gives the lens designer four surfaces with which to correct aberrations, instead of only three surfaces, as with a cemented achromat. The result is a beautiful, color-free image, an image which is sharp, clear, with maximum freedom from spherical aberration. There are no bad zonal aberrations and no coma. This objective is not coated because we believe any coated objective after being cleaned a few times will scatter light and become inferior to an uncoated objective. This is your chance to build a 3" refractor at low cost. A refractor with a lens as good as this one would cost you about $400.00, if bought ready-made! We supply free with this lens a specially designed, spiral-wound laminated Kraft board mount which is designed to slip over our 3" aluminum tube. This effectively solves your mounting problem.

STOCK #30,166-Y — 3" Achromatic Objective Color-corrected — air-spaced ..... $28.00 ppd.

Coming Soon! From the same manufacturing source, 2" x 50" f.l. and 4" x 60" air-spaced achromats! If you want information on these new objectives, write for Bulletin #30. We will send it as soon as it becomes available.

4¼" ASTRONOMICAL TELESCOPE

BRAND NEW! 'Palomar, Jr.'

ONLY $74.50 COMPLETE

A REAL REFLECTOR TELESCOPE
Complete with Equatorial Mount, Tripod

Rack and pinion, micrometer-smooth focusing with tension adjustment. Two-piece rigid diagonal construction. All-aluminum black anodized tube. No-distortion adjustable mirror mount, easily removed for mirror cleaning. Tube ventilated. Real equatorial mount — one smooth motion follows stars, planets. Sturdy hardwood tripod. Counterweight for perfect balance.

Stock #85,006-Y ..... complete, $74.50 f.o.b.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as above, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y ..... $16.25 ppd.

7X — FINDER TELESCOPE — ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts $9.95

Stock #50,075-Y Ring mounts per pr., $4.95

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞"	5¼"	46"	Spiral-wound paper	$2.50
85,008-Y	7"	7½"	60"		4.00
85,011-Y	2¾"	3"	48"	Aluminum	6.00
85,012-Y	3¾"	4"	60"		8.75
85,013-Y	4¾"	5"	48"		9.00
85,014-Y	6¾"	7"	60"		15.00

All tubing is shipped f.o.b. Barrington, N. J.

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys at these low prices!

HUYGENS TYPE — STANDARD 1¼" DIA.

6 mm (¼") Focal Length

STOCK #30,063-Y ..... $8.50 ppd.

12.5 mm (½") Focal Length

STOCK #30,064-Y ..... $8.00 ppd.

COMBINATION EYEPIECE

STOCK #30,065-Y ..... $9.00 ppd.

This Huygens eyepiece, used in different arrangements of the lens elements, gives focal lengths of 10 and 20 mm, allowing you to double the power of any objective or primary mirror. Standard equipment with our Palomar, Jr. reflecting telescope. Easy directions for assembling for different powers are included.

RACK & PINION EYEPIECE MOUNT

. . . Available with Diagonal Holder

Now—you can improve performance in a most important part of your telescope—the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these wonderful new features: Real rack and pinion focusing, with variable tension adjustment, gives you microscope-smooth focusing action. Focus travel over 2". Drawtube accommodates standard 1¼" eyepieces, giving your present telescope a wide, varied range of power. Standard size opening also allows the use of accessory equipment, such as sunspot projectors, filters, eyepiece prism diagonals and terrestrial erectors. Lightweight aluminum body casting. Rigid mounting achieved by drilling four small holes in tube, whether paper or metal. Drawtube and rack chrome plated brass, body in black wrinkle finish.

Stock #50,077-Y (less diagonal holder) 9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.

MOUNTED ERFLE EYEPIECE

68° FIELD OF VIEW

Consists of 3 coated achromats in metal mount with spiral focusing. F.L. 1¼". Dia. 54 mm., length 54 mm. War surplus. Govt. cost about $84.00. This is the type war surplus bargain that will be talked about in years to come. Buy while you can. Our price will jump soon.

Stock #5160-Y, 12.50 ppd.

WAR SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3, 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for all types of telescopes. Govt. cost $26.50.

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SPHERICAL TELESCOPE MIRRORS

Ground, polished, aluminized, silicon monoxide overcoated. You can't buy better quality. Remember, good Spherical Mirrors of f/10 and higher, are perfectly satisfactory for reflecting telescopes.

STOCK NO.	DIAM.	FOCAL LENGTH	PRICE
50,082-Y	3"	30"	$9.95
50,051-Y	4¼"	45"	15.00

RIGHT ANGLE PRISMS

Excellent for use as a diagonal on a Newtonian telescope. Also used in refractors to bend light rays for more comfortable viewing. For dimensions, refer to the diagram. These are all within ¼ wave length tolerance.

STOCK NO.	Dimension of Faces	Price ppd.
3252-Y	24 x 24 m.m.	$2.50
3155-Y	31 x 31 m.m.	3.00
3255-Y	38 x 38 m.m.	3.50
3169-Y	41 x 40 m.m.	3.00

BE SURE TO GET FREE CATALOG "Y"
Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for *Free Catalog "Y"*.

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Designed by Armand Spitz. Projects nearly 400 stars, more than 70 constellations in their correct relationships. Use it in any darkened room of the house, project it on walls and ceiling. No batteries, works on ordinary household current. Two simple adjustments that show you the sky as it appears from any point in the Northern Hemisphere . . . for any time of night . . . for any month of the year! Rheostat brightness control. A 32-page book included free of extra cost. Contains valuable information about the stars, provides easy identification of the constellations.

About 14" high on a 7" x 7" base. Projection sphere 7" diameter. Weight 3 lbs.

Stock #70,040-Y ..... $14.95 ppd.

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MOUNTED BARLOW LENS — Short Focal Length. E.F.L.: —1.74±0.01 inches. Clear aperture: 0.96" O.D. of cell: 1 3/8".

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60° SPECTROMETER PRISM — Polished surfaces 18 mm x 30 mm — flat to ½ wave length.

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Ellipse 1.25" x 1.77" . . $10.00

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Aluminum coating $1.00 extra.

Send for list of other sizes, quartz mirrors and mirror blanks.

BAUSCH & LOMB BALSCOPES

Choice of 15x, 20x, 30x, or 60x eyepiece, postpaid **$95.00**

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Reflecting Telescope Kits

Our kits have PYREX mirror blank, PYREX tool the same thickness, ample supply of optical quality abrasives, fast polishing cerium oxide, red rouge and pitch. Packed in metal cans.

Size	*Thickness*	*Price*
4¼"	¾"	$ 5.50
6"	1"	$ 9.50
8"	1½"	$17.00
10"	1¾"	$29.95
12½"	2⅛"	$52.95

ADD POSTAGE: 1st and 2nd postal zones from Detroit, add 5%; 3rd and 4th, add 10%, 5th and 6th, add 15%; 7th and 8th, add 20%. Or we will ship C.O.D.

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rapid cooling prevents cracking the objective.

The beeswax is not hygroscopic, that is, it does not permit the passage of moisture and it does not absorb moisture. Paraffin is unsuitable as it is hygroscopic.

FRANK L. GOODWIN
345 Belden Ave.
Chicago 14, Ill.

A SUBSTITUTE FOR CROSSHAIRS

The following idea may be new to some readers. Instead of crosshairs in my finder, I have attached a needle at the focus, so that its point extends into the field of view. The needle is clearly visible against the night sky. The planet or star to be observed is placed just off the point of the needle. This arrangement is simpler to install than crosshairs, and for me it works just as well.

GORDON HALL
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'Tis twenty years come Michaelmas
Since first I started grindin' glass,
Sleepless nights of frenzied action,
A telescope bein' the attraction.
Carbo, emery, rouge refinin',
Formulas the shapes definin'.
Curves beguilin', pitch revilin',
How the missus used to holler
When the fumes got in the parlor.
Shadows dancin', knife-edge prancin',
Close the doors to stop the churnin'.
Hills and hollows, edge kept turnin',
'Nuff to make a man bucolic,
Tryin' to keep it parabolic.

Had it 'luminized; how it glittered,
Except for pits and scratches littered.*
Spider, cell, and collimation,
Prettiest thing in all creation,
Swingin' on its mount cemented,
And to the North Star oriented.
Oh! the glory of the feelin'
When the moon broke through the ceilin'
Of the clouds,
And the sparklin' Sisters Seven,
And all the glitterin' jewels of heaven
Popped through the shrouds.
Supper cold, and way past midnight,
Though skeeters hummed, or toes felt frostbite!

But came the winter, snow lay on it,
In the spring the bearin's rusted,
With the summer, bees moved in it,
And the mirror—cobweb-dusted.
Promised next year I'd restore it,
But neighbors' trees grew up and o'er it.
The stars in vain their light would send
To seek their fickle faithless friend.
Well! Got another hunk of glass,
And that wreck out in the grass
Will have a buddin' hopeful brother,
Come Michaelmas.

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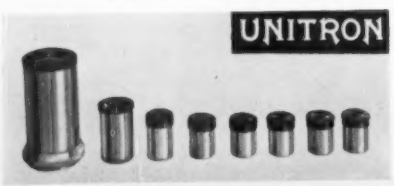

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● RACK-AND-PINION FOCUSING for accurate adjustment.

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● EQUATORIAL MODELS have slow-motion controls for both declination and right ascension as well as rapid-motion controls.

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See the outside back cover.

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

A Conjunction of Jupiter and Uranus

ON MAY 10, 1955, at 21 hours UT, there will be an extremely close conjunction of Jupiter and Uranus, with a minimum separation of 55 seconds of arc. The apparent polar diameter of Jupiter will be 32.6 seconds of arc, and that of Uranus 3.6 seconds. When they are closest, the gap between the nearer limbs of the two planets will be only 37 seconds—about one diameter of Jupiter!

Although the planets will be on the celestial meridian on the New England coast at 21 hours, daylight will obscure them when they are closest. The conjunction will be best observed in the British Isles and in the eastern part of South America. However, for several evenings before and after this Uranus and Jupiter will be very close together in the sky, and will be well worth observing with moderate optical power from anywhere in the United States.

The presence of the four Galilean satellites of Jupiter will add to the spectacle as Uranus passes each in turn. Unfortunately each of the conjunctions of Uranus with a satellite occurs in daylight or below the horizon throughout the Americas. Nevertheless, the ever-changing pattern will be a fascinating sight on the evenings from May 9th to 13th.

Jupiter's satellites can be identified from the configuration diagram for each night that appears at the right. Uranus will pass slightly north of each satellite, and will remain on the north side of the line of satellites until the evening of May 13th. Actually, it is Jupiter which is overtaking Uranus as both planets move eastward among the stars, the brighter one moving four times as fast. At the time of conjunction, Jupiter will be magnitude −1.5 and Uranus 5.8; the magnitudes of Jupiter's satellites will be **I**, 6.2; **II**, 6.4; **III**, 5.8; and **IV**, 7.0.

On the evening of the 10th, when Uranus is nearest Jupiter, satellite **I** ends its transit of the Jovian disk at about sunset in the Atlantic coastal states. Io's shadow on the planet's disk should be easily visible, however, as egress takes place at 1:47 UT, more than an hour later.

This is the third of a series of three conjunctions of the two planets this season. The first was on October 8, 1954, when Uranus was 21 minutes north of Jupiter, relatively remote from the compact system of the giant planet and its moons. The second conjunction took place on January 6, 1955, with the fainter planet only nine minutes to the north, and it was a delight to watch in a binocular the night-to-night changes in position for a week.

PAUL W. STEVENS
Rochester Academy of Science

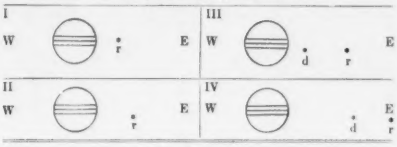
JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

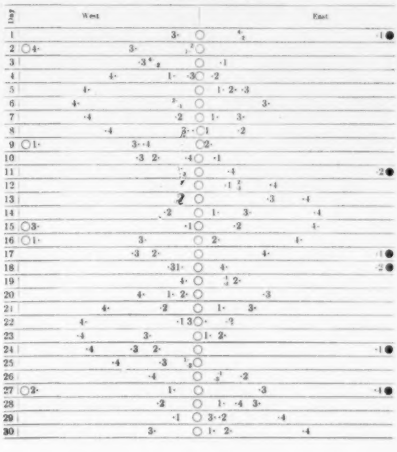
In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.

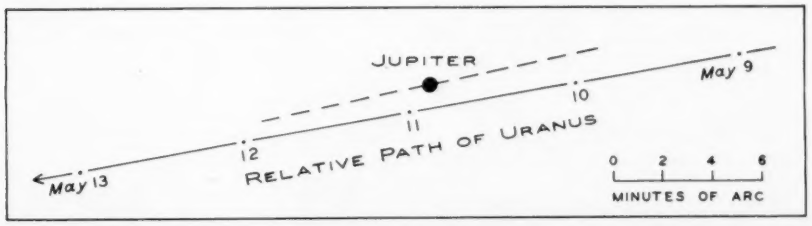
APRIL

Phases of the Eclipses of the Satellites



Configurations at 3h 45m





The May, 1955, conjunction of Uranus and Jupiter. Positions of Uranus are marked for 0h UT of the dates indicated; these moments correspond to 7 p.m. EST of the preceding date. The broken line through Jupiter indicates approximately the region in which its four large satellites move. North is below, as in an inverting telescope; observers using binoculars should turn this diagram upside down.

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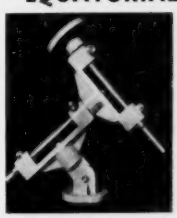

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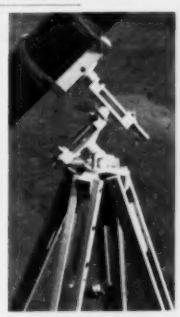

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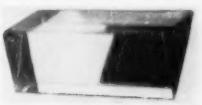

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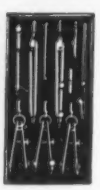

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VARIABLE STAR MAXIMA

April 2, R Leporis, 045514, 6.7; 5, RS Cygni, 200938, 7.4; 7, R Geminorum, 070122a, 7.1; 15, R Ophiuchi, 170215, 7.6; 17, R Cancri, 081112, 6.8; 19, T Hydrae, 085008, 7.7; 19, R Virginis, 123307, 6.9; 19, Chi Cygni, 194632, 5.3; 25, W Lyrae, 181136, 8.0; 30, U Herculis, 162119, 7.6.

May 1, R Pegasi, 230110, 7.9; 8, S Carinae, 100661, 5.7.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Irene, 14, 8.9. April 23, 15:38.1 −8-23. May 3, 15:29.9 −8-16; 13, 15:20.3 −8-18; 23, 15:10.7 −8-31. June 2, 15:02.4 −8-56; 12, 14:56.7 −9-35.

Metis, 9, 9.4. April 23, 15:43.8 −16-28. May 3, 15:34.9 −16-12; 13, 15:24.9 −15-53; 23, 15:14.7 −15-35. June 2, 15:05.5 −15-21; 12, 14:58.1 −15-14.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1955.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

SUNSPOT CYCLE NOTES

The most active sunspot cycle in the past 170 years ended in April, 1954, according to recent analysis of the smoothed American sunspot numbers prepared by the Solar Division of the American Association of Variable Star Observers. Expressing dates as years and decimals, the cycle began at 1944.2, reached its maximum at 1947.5, and minimum again occurred at 1954.3.

Compared to the 1933.8 minimum, when the monthly number was 7.7, the recent minimum was only 2.4. The 1947.5 maximum, at 151.8, far surpassed that of 1937, which was 119.2. The cycle just ended lasted 10.1 years; the preceding one lasted 10.4 years.

If the new cycle continues to increase in activity at its present pace, it is also very likely to be a high one, and solar activity should be at its peak during the International Geophysical Year in 1957-58.

HARRY L. BONDY
AAVSO Solar Division

SUNSPOT NUMBERS

January 1, 21, 22; **2,** 16, 17; **3,** 16, 11; 4, 29, 19; **5,** 37, 32; **6,** 53, 22; **7,** 57, 23; **8,** 47, 29; **9,** 38, 31; **10,** 28, 36; **11,** 32, 33; **12,** 31, 31; **13,** 28, 28; **14,** 17, 27; **15,** 16, 18; **16,** 17, 16; **17,** 14, 15; **18,** 11, 10; **19,** 10, 9; **20,** 4, 7; **21,** 8, 8; **22,** 9, 8; **23,** 22, 8; **24,** 22, 19; **25,** 15, 21; **26,** 25, 25; **27,** 26, 25; **28,** 16, 19; **29,** 13, 16; **30,** 21, 12; **31,** 22, 22. Means for January: 23.3 American; 20.0 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by D. W. Rosebrugh from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

COMET BAADE

The 15th-magnitude comet discovered last July 31st by Dr. Walter Baade, of Mount Wilson and Palomar Observatories, has brightened sufficiently to be visible in large amateur telescopes. Recent calculations by Dr. L. E. Cunningham, of the Leuschner Observatory, indicate that the comet will make its closest approach to the sun on August 13, 1955, but at the unusually large perihelion distance of 3.9 astronomical units.

This object will remain well placed for Northern Hemisphere observers throughout the year. Now crossing the constellation of Camelopardalis, Baade's comet will be in Auriga at year's end. The brightness is expected to change little, staying about magnitude 12.5 from now until August, and then rising to 11.8 by December.

Predicted comet magnitudes are always uncertain, and in any event a 12th-magnitude comet, as it is an extended area, requires a larger telescope than does a 12th-magnitude star. Instruments of 10 inches aperture or more seem advisable for locating Baade's comet. The following right ascensions and declinations (1955 co-ordinates) are from predictions by Dr. Cunningham on Harvard Announcement Card 1285. They refer to 0^h Universal time.

April 3, 3:43.1, +76-30; 13, 4:15.7, +73-45; 23, 4:41.6, +71-07. May 3, 5:03.4, +68-38; 13, 5:22.4, +66-20; 23, 5:39.4, +64-11. June 2, 5:54.9, +62-12; 12, 6:09.1, +60-22; 22, 6:22.2, +58-40. July 2, 6:34.3, +57-07; 12, 6:45.4, +55-41; 22, 6:55.5, +54-22.

DEEP-SKY WONDERS

CONCERNING our discussion in January, many amateurs have written me that they too could see the Triangulum galaxy M33 with the naked eye; and the majority are from states east of the Mississippi River where seeing conditions are none too good. Leslie Peltier says that M33 is too easy and suggests that observers try M2 in Aquarius.

However, in spring skies we have a globular cluster, M3, with an integrated visual magnitude of about 6.1, and it would be interesting to see if this object, about equally bright but considerably smaller, is easier or harder to locate with the naked eye than M33. The writer will welcome a postcard.

This globular, NGC 5272, is in Canes Venatici at 13^h $39^m.9$, $+28°$ 38′ (1950 co-ordinates). Its main body is 9.8 minutes of arc in diameter, according to Shapley, but both he and Mowbray find about twice this diameter for its faint outlying parts. While M3 is less familiar to amateurs than M13, the former is more important to the astronomer for its numerous variable stars, of which 186 are known, as against 15 for the Hercules cluster.

The 200-inch photograph of M3, reproduced on the January, 1953, back cover of *Sky and Telescope*, shows an overpowering mass of stars that extend out in profusion from the compact nucleus. Small telescopes of course will not show this, but a 10-inch reflector reveals M3 as a most spectacular object, easily resolved for some distance in from the edge, and in moments of fine seeing the resolution extends even over the uniformity of the central part. The core does not lie in the exact center of the blaze, but we have none of the long blunt rays that seem so conspicuous when M13 is examined. On a fine evening, M3 fairly blazes with diamond starlight.

WALTER SCOTT HOUSTON

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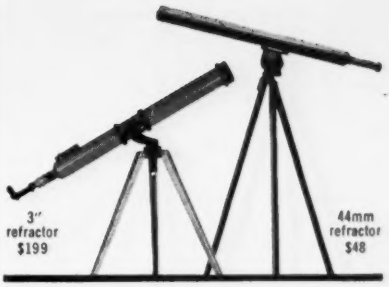

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VISUAL MAGNITUDES OF SOME MESSIER OBJECTS

A SIMPLE and fairly accurate method of determining the brightness of a comet is to compare it with neighboring stars, using binoculars or a telescope set enough out of focus so that comet and star images are similar in appearance. The same method can also be applied to bright star clusters and nebulae, and I have observed some of these as a control on my comet observations.

The following results for a few Messier objects were obtained with 5 x 40 binoculars, using comparison star magnitudes from the *Harvard Revised Photometry*. For each object are listed its Messier number, constellation, type (Gb, globular cluster; Cl, open cluster; and S, galaxy), observed magnitude, and the number of observations.

M3	CVn	Gb	6.5	(2)
M11	Sct	Cl	6.0	(9)
M13	Her	Gb	6.1	(3)
M22	Sgr	Gb	5.7	(4)
M25	Sgr	Cl	5.3	(3)
M33	Tri	S	6.1	(3)
M34	Per	Cl	5.7	(3)
M35	Gem	Cl	5.5	(4)
M41	CMa	Cl	5.8	(2)
M44	Cnc	Cl	4.5	(4)

As an indication of the internal consistency of these results, the average deviation of the nine observations of M11 from their mean is ±0.08 magnitude.

Systematic estimates of the total magnitudes of clusters and nebulae by this method should be an attractive project for the amateur, particularly if he has already had experience in estimating the brightness of variable stars. Data of this sort are useful, but are not easy to find in the literature.

Two precautions are necessary: Such observations require moonless nights, and the observed magnitudes will come out too faint unless the images are far enough out of focus for a good match in appearance.

J. A.

MOON PHASES AND DISTANCE

Full moon	April	7, 06:35
Last quarter	April	15, 11:00
New moon	April	22, 13:06
First quarter	April	29, 04:23
Full moon	May	6, 22:14

	April	Distance	Diameter
Apogee	11, 14h	251,800 mi.	29′ 29″
Perigee	23, 19h	223,500 mi.	33′ 13″
	May		
Apogee	9, 00h	252,300 mi.	29′ 26″

APRIL METEORS

The Lyrid meteor shower will occur under favorable conditions this year, as the moon is new on April 22nd, the date of maximum activity. The best time to observe the shower is after midnight, when the radiant is higher in the sky. Then, if skies are clear, about 12 Lyrids per hour can be expected, proceeding from a radiant point at 18h 12m, +34°, southwest of Vega. The duration of this shower is two days.

E. O.

A REPORTED LUNAR CHANGE

In the northern part of the interior of the lunar crater Vendelinus is a smaller crater, from which T. G. Elger in 1891 discovered a cleft running north. He saw this crack again, using an 8½-inch reflector, and it was confirmed by W. H. Maw with a 6-inch refractor. Later observers, such as H. P. Wilkins and R. Barker, have been unable to find the cleft.

Dr. Wilkins now reports, in the November, 1954, *Journal* of the British Interplanetary Society, that when he visited Mount Wilson Observatory a few months earlier he examined this region visually with the 60-inch reflector, power 500.

He could not see Elger's cleft, even though the conditions of illumination were similar to those at its discovery, and in fact there was a long ridge of mounds where Elger drew the cleft. On the other hand, two hitherto unrecorded cracks were seen, parallel to and on either side of this ridge.

Dr. Wilkins' suggestion that actual change has occurred in this part of the moon would be of considerable importance if substantiated, so that further examination of Vendelinus by experienced lunar observers is desirable.

OCCULTATION PREDICTIONS

April 10-11 **19 Scorpii** 4.8, 16:17.9 −24-03.7, 18, Em: **H** 10:35.8 −2.5 0.0 276; **I** 10:29.4 −1.6 +0.1 295.

April 12-13 **4 Sagittarii** 4.8, 17:57.0 −23-48.8, 20, Em: **F** 7:18.0 −0.2 −1.0 323.

April 13-14 **Nu¹ Sagittarii** 5.0, 18:51.5 −22-48.1, 21, Em: **D** 9:30.6 . . . . . 202.

April 13-14 **Nu² Sagittarii** 5.0, 18:52.4 −22-43.8, 21, Em: **E** 9:47.8 −2.0 +2.6 207.

April 24-25 **Upsilon Tauri** 4.4, 4:23.6 +22-42.8, 2, Im: **A** 23:57.8 −0.1 −1.9 117; **B** 23:52.1 −0.3 −1.7 110; **C** 24:05.4 0.0 −2.5 135.

April 24-25 **MARS** 1.8, 4:30.9 +22-43.8, 2, Im: **B** 2:30.8 +0.4 −1.1 94; **D** 2:35.3 +0.4 −1.3 103; **E** 2:45.6 +0.4 −1.8 124; **I** 2:27.3 −0.3 −2.8 134. Em: **E** 3:31.0 +0.1 −0.5 244; **I** 3:14.9 −0.8 −0.3 231.

May 23-24 **Eta Geminorum f** 3.2-4.2, 6:12.2 +22-31.3, 2, Im: **F** 2:07.8 −1.1 +0.7 46.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo,** lat. **L**) within 200 or 300 miles of a standard station (long. **LoS,** lat. **LS**). Multiply **a** by the difference in longitude (**Lo** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

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Copies are still available, but in *very* limited quantity. While these last, they are yours for the asking. This attractive calendar is but one of over 25 pieces of informative literature (over ¼ lb.) which is rushed to you on receipt of your inquiry. Our catalog illustrates and fully describes all UNITRON models. A special section tells you how to choose a telescope and explains important telescope terminology. Read actual observation reports from UNITRON owners and learn about some of the well-known university and government observatories which use UNITRON Refractors. This literature is required reading not for telescope buyers only but for all astronomers who want to find out more about the famous UNITRON Refractors—the telescopes that are playing a leading role in astronomy today.

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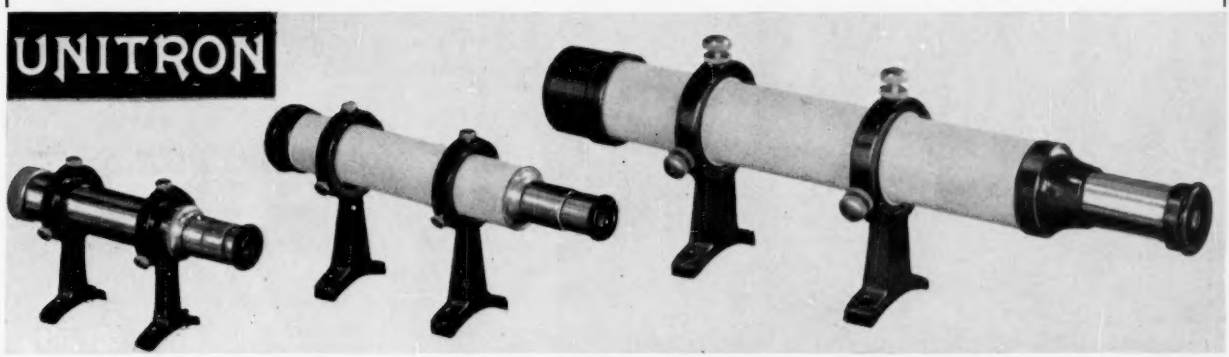

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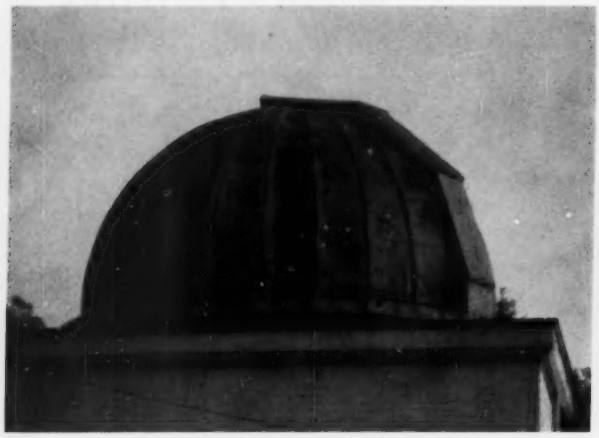

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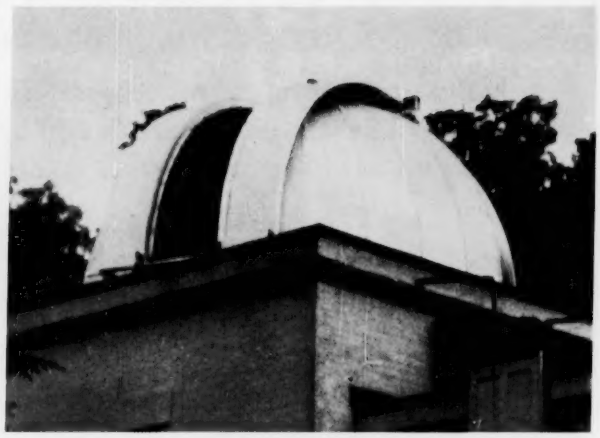

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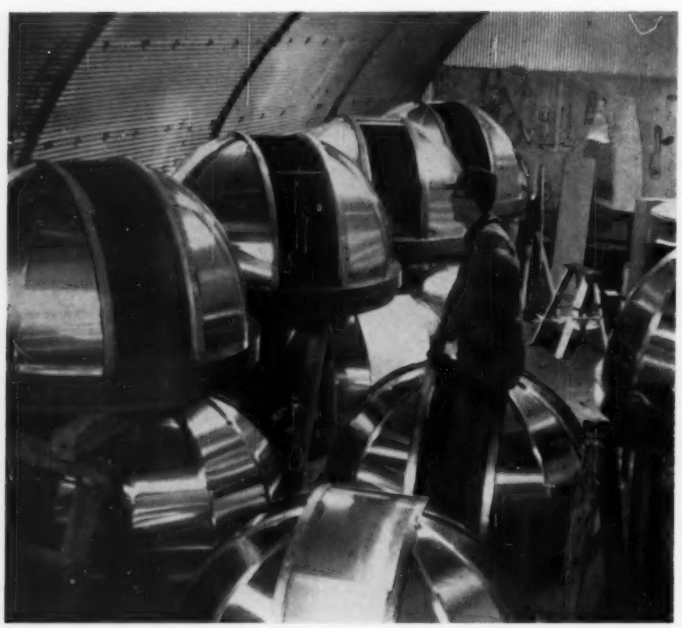

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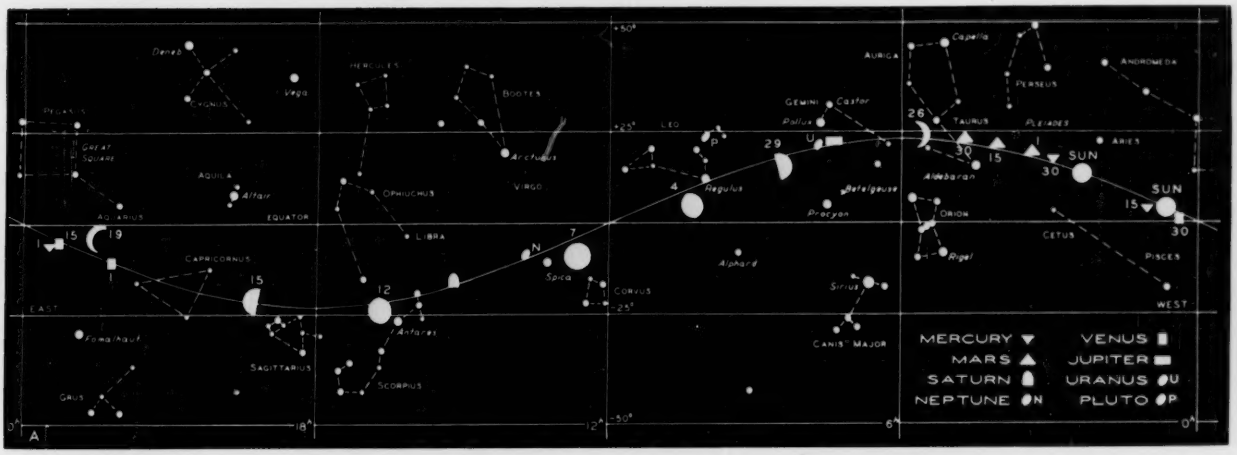

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shewn for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury will not be visible this month, as it passes superior conjunction with the sun on April 23rd.

Venus, in the morning sky, continues its rapid eastward motion across Aquarius and into Pisces. On the 15th, when Venus rises 1½ hours before the sun, it shines at magnitude −3.4. The planet's disk will then appear 13″.5 in diameter and 80 per cent illuminated.

Mars, now a 2nd-magnitude object in Taurus, sets three hours after the sun in midmonth. The ruddy planet may be found south of the Pleiades early in the month and northeast of Aldebaran at the end of April. On the evening of the 24th, there will be a close approach of Mars and the crescent moon, and the planet will be occulted in parts of the United States and Canada. Circumstances of this event are given in the list of occultation predictions on page 254. Seen from the center of the earth, conjunction of the moon and Mars will occur at 1:51 UT on the 25th, with Mars 45′ south.

Jupiter arrives at eastern quadrature with the sun on April 11th, setting about 1:30 a.m. local time. Moving slowly eastward in Gemini, at midmonth the planet is of magnitude −1.7, and the telescopic disk is 38″ in equatorial diameter.

Saturn rises two hours after sunset in mid-April, when it appears as a +0.4-magnitude object. With opposition occurring next month, Saturn is in retrograde (westward) motion in Libra. The ring system, easily seen in small telescopes, is inclined 21°.8 to our line of sight on the 15th.

Uranus attains eastern quadrature on the 14th, three days after Jupiter does so. The two planets are then only 2½° apart. The path of Uranus, a 6th-magnitude object, is charted on page 169 of the February issue.

Neptune will be at opposition on April 17th, and hence it is observable all night, an 8th-magnitude object. Its distance from the earth will then be 2,726 million miles. Its location among the stars in Virgo is given on the chart that accompanies the Uranus chart mentioned above.

E. O.

LUNAR APPULSE OBSERVED

On the morning of January 8, 1955, I was able to observe the moon within the penumbral shadow of the earth, from 6:20 CST, when the sky cleared around the moon, until moonset at 6:47. The darkening was very prominent, both to the naked eye and in a 3-inch telescope, appearing brownish in contrast to the brilliant yellow of the southern limb. This darkening, which was most noticeable around the crater Plato, did not change much in intensity during the period I watched the appulse.

ROGER CUFFEY
522 Eastside Drive
Bloomington, Ind.

Here near the Pacific Coast, the penumbra was very faintly seen at 3:10 a.m. PST, but 30 minutes later it seemed darker and larger. At 4:00, it was easily seen, as were the lunar features on which it fell. The penumbra was very dark at 4:32, the maximum of the appulse. By 6:00, it was barely discernible, almost off the moon's surface.

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MINIMA OF ALGOL

April 1, 5:12; 4, 2:01; 6, 22:50; 9, 19:39; 12, 16:29; 15, 13:18; 18, 10:07; 21, 6:56; 24, 3:45; 27, 0:34; 29, 21:23. May 2, 18:12; 5, 15:01; 8, 11:50.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

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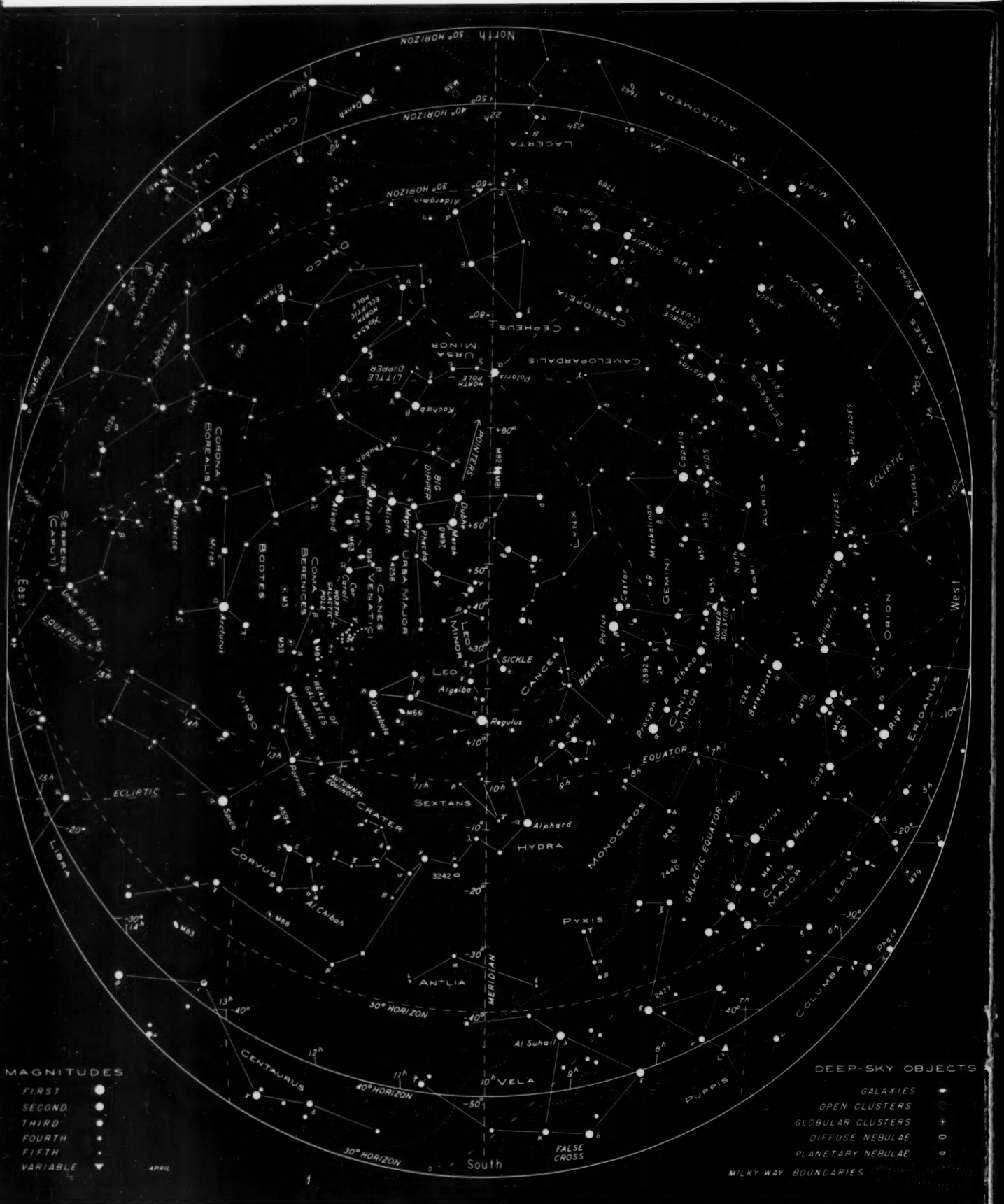
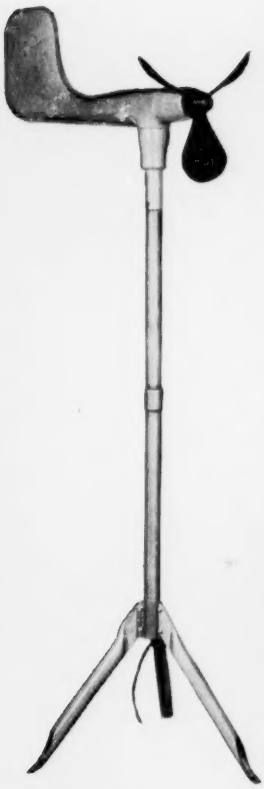


STARS FOR APRIL

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of April, respectively; also, at 7 p.m. on May 7th. For other dates, add or subtract ½ hour per week.

Now, as Orion dips low in the southwest, the constellation Leo is easily found high in the south. At the handle of its Sickle is 1st-magnitude Regulus. Follow a line from Algeiba through Regulus to locate the orange star Alphard in Hydra, the Water Monster.



WEATHER STATION EQUIPMENT

The Windial

No. 476 This is the best all-around wind indicating system. It has been adopted by the U. S. Weather Bureau and the CAA as standard equipment at airports and is employed extensively in industrial enterprises and at educational institutions.

The WINDIAL transmitter combines an anemometer and a wind vane in a single unit. The 3-bladed propeller transmits wind speed through a telemetering system to the WINDIAL indicator. The wind vane transmits wind direction in the same way.

The WINDIAL indicator has matching dials for speed and direction mounted in an attractive gray cabinet. Wind speed is indicated up to 120 m.p.h.; wind direction is shown both in degrees and in cardinal points on a compass dial.

The WINDIAL is simple to install—requires no servicing. It can be operated on 110-volt house current or on batteries. It is shipped complete, ready for installation, with transmitter, tripod transmitter support 6 feet high, 50 feet of cable and indicator unit.

Shipping weight 72 lbs. **$325.00**

Sling Psychrometer

No. 208 U. S. Weather Bureau type. Two 9½″ matched thermometers are mounted on a stainless steel backing. Swivel handle for whirling. Thermometers graduated in one-degree increments from —20° F. to +120° F. Length 12″. Weight 5 oz. Complete with sock and psychrometric table. **$10.00**

No. 209 Carrying case for No. 208. All metal. Length 14″. **$3.00**

Rain and Snow Gage

No. 503 U. S. Weather Bureau type. Gage consists of four components: 8″ brass collector and funnel; copper overflow can, 24″ overall height; brass inner measuring tube 2.53″ in diameter and 20″ deep; and a red-cedar measuring stick with graduations to 0.01 inch. Gage has total rainfall capacity of 20 inches.

Weight 8 lbs. **$25.00**

No. 504 Support for Rain Gage. Steel support rests on tripod to insure correct position and exposure for No. 503. **$15.00**

Write for complete catalog

Meteorological Barometer

No. 306 U. S. Weather Bureau type. Best grade movement compensated for temperature. Brass case with 5″ dial. Dual graduations in both inches and millibars. Range: 26.00 to 31.50 inches pressure and from 850 to 1060 millibars. For sea level to 3,000 feet. **$38.50**

No. 307 for elevations from 2,000 to 6,000 feet. **$44.00**

No. 308 for elevations from 4,900 to 9,500 feet. **$44.00**

Maximum-Minimum Thermometers

No. 111 U. S. Weather Bureau type. Set consists of mercury-filled maximum thermometer, alcohol-filled minimum thermometer, and all-metal Townsend support. Both thermometers are 10½″ long with graduations etched on glass stem. Range: —50° F. to +130° F.

$25.00

SCIENCE ASSOCIATES

194 Nassau Street
Box 216
Princeton, New Jersey

UNITRON

CAUCUS-RACE CONTEST ENDS

Remember the Caucus-Race?

Remember the Caucus-race? If you don't, we'll wait while you locate your copy of **Alice's Adventures in Wonderland** and turn to Chapter III. Mislaid the book . . .? Well, surely you remember how the contestants were "placed along the course, here and there. There was no 'one, two, three, and away!' but they began running when they liked, and left off when they liked, so that it was not easy to know when the race was over." When finally the Dodo called out, "The race is over," everyone wanted to know the winner. The conclusion was that **"Everybody** has won, and **all** must have prizes."

Well, we at United Scientific Co. find that our brief, informal request for suggestions for

A distinguished panel of judges.

a name for the UNITRON Rotary Eyepiece Selector has turned into a Caucus-race type of contest. The sponsors (UNITRON) didn't even know that it was a real contest, the contestants (all of you helpful astronomers) were not told the rules, and no one knew when the whole affair was to end. Under the circumstances, it seems only appropriate to follow this situation to its illogical conclusion. We have, therefore, engaged at considerable expense, and practically no cost, a distinguished panel of judges whose first order of business has been to have a group picture taken in their official Caucus-race costumes. On Julian Day 2,435,-157.16, at a meeting held in the Dodo's office at 204-6 Milk Street, the contest was declared to be at an end and all of the following names were judged to be among the winning ones:

All-Power Selector, Astro-Magna Six Selector, Celesturret, Cosmic Six Shooter, Double Trimount, Eyesixscopes, Eye Wheel Six, Handy Hexigol Eyepiece Holder, Hexaclops Selector, Hexadapter, Hexadiagonal Rotocular, Hexa-Dial, Hexagonal Degree Lens, Hexagonal Turret Eyepiece Selector, Hexalector, Hexa-Magnifier, Hexa-Power, Hexar, Hexares, Hexarightangular Rotocular, Hexa-Rotary Eyepiece, Hexa-Rotary Eyepiece Selector, Hexigon Rotary Eyepiece Adaptor, Hexarotocular, Hexa-Roto Eyepiece Selector, Hex-A-Rotor, Hexatron, Hexatron Selector, Hexaturret, Hexaview, Hexazenithal Rotocular, Hexa-Viewer, Hexelector, Hexeye, Hexi Eye-Power Turret, Hex-Eye Rota, Hexitron, Hexitron R-1, Hex-lector, Hexocular, Hexocular Rotary Turret, Hexocular Rotaselector, Hexocular Turret, Hexophthalmotrope Adapter, Hexorama, Hexosphere, Hexoturret, Hexox, Hex-Selector, Hextet, Hex-Turret, Hexunocol, Hex-Vue Turret, I-Magni-Turret, Instantsix Eyepiece, Magic Eye Index, Magnification Selector, Magni-Sextet, Magnivar, Mult-Eye-Six, Multi-Focal, Multi-I-Turret, Multi-Mag, Multiplar, Multiple Eyepiece Adapter, Multiscopic Turret, Multiselector, Multiselectron, Multi-Turret Eyepiece, Multi-UNITRON Eyepiece, Ocular Range Selector, Ocular Selector, Omnipower Wheel, Ocular Turret, Panocular, Poly-Ocular Selector, Radial Hexoptical, Range Selector, Rotahex, Rotary Hex-Eye-Gonal, Rotary Hexocular, Rotary Multiple Ocular Selector, Roto-Qwikpik, Rotary Sextascope, Rotary Sextet Eyepiece, Rotary 6, Rotary Six-Eyepiece, R-6, Rotary 6 Sight Selector, Rotocular, Roto-Flex, Roto-Hex Eyepiece, Roto-Hexocular Selector, Rotosix, Rotosix Eyepiece, Roto-Star, Rot-Otron, Roto-Viewer, Roto-Vue, Select-A-Power, Selecti-Six-Eyepiece, Selective Six, Selective Six-Eyepiece, Selectoscopar, Selectoscope, Selecto Six, Selectron, Selectron Turret, Selectrotor, Selecturn, Selexahex, Sexlector, Sexlocular Eyepiece Adaptor, Sexocular, Sexrolector, Sextet Eyepiece Rotary, Sextet Range Selector, Sextron, Sextuple Eyepiece Selector, Sextuple Rotary Eyepiece, Simplex Vari-Power Selector, Six-I, Six Eyepiece Turret, Six-eyescopes, Six-Eye Turret, Sixitron Roto-Lens Selector, Sixops, Sixox, Six-Shooter, Six Stage Turret Head, Sixtet Celestial Selector, 6-in-1 Eyepiece, 6-in-1 Rotary Eyepiece, 6-Oc-Selector, 6-Rotary Eyepiece, Startuplet, Sky Wheel Six, Super Six Eyepiece Selector, Tel-E-Lens Selector, Turret Head Eyepiece, Turret Eyepiece, Turret Eyepiece Selector, Turret Ocular, Turretron, Uni-Eye, Unihex, Unirotary, Uni-Six Ocular, UNITRON Multoculector 6, UNITRON's Universal Unit, Uniturn, Uniturret, Var-Eye-Six, Variable Eyepiece Rotary, Varioscopic Eyepiece, Varipar, Varipower Eyepiece, Varitron, X-I Rota.

Winners Selected

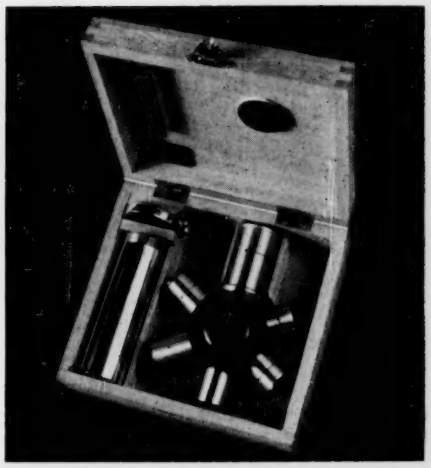
The winners were officially declared to be those persons listed below (obviously the names are not in alphabetical order, since this is a Caucus-race type of contest) and each winner is to receive as a prize, with the compliments of UNITRON, a copy of the book, **The Nature of the Universe,** by Fred Hoyle:

L. Gfell, R. Sheppard, W. Munn, A. Shapiro, E. Young, J. Wisdom, A. Parandes, T. Brooke, E. Parnitzke, Jr., J. Leary, G. Thomsen, R. Bennett, W. Perkins, W. Wickman, W. Krah, J. D'Igalo, A. Kudish, P. H. Smith, S. Putnam, N. D. Smith, Mrs. S. Franklin, R. Heisey, W. C. Smith, J. Kuzanek, R. Tullis, E. Melville, A. Cavill, H. Turner, M. Good, W. Benjamin, D. Sumrill, O. T. Smith, L. Kelley, A. Starr, K. Walker, E. Wroblewski, W. Wozniak, E. Roder, H. Pfleumer, M. Tatum, L. Mussgnug, W. Wilt, G. Landon, W. Shockey, Mrs. M. Sadoski, B. Ragland, D. Alves, F. Solsem, J. Green, R. Armstrong, J. Eberly, Jr., J. Ericson, A. Ellett, B. Cottingham, H. Wambugh, L. Goldstone, J. Pulsifer, R. Reynolds, R. Snyder, N. Dalke, Fr. M. Adrian, A. Barrett, E. Onstott, Rev. S. Herrmane, H. Chase, J. Tolkien, K. Ryerson, C. Capen, Jr., E. Kurey, Mrs. W. Titus, R. Clatfelter, P. Liston, H. Courley, S. Iverson, V. Richey, F. Hurst, Jr., M. Baghdasarian, R. Lomprey, W. Johnson, M. Sloan, R. Kinnear, T. Wilson, A. Young, S. Tigner, G.

No room to engrave all the names.

Emond, D. Rosenfield, J. Wooley, Rev. H. Toms, J. Cracroft, E. Mentall, G. Cooper, C. Avney, W. Calder, R. Ronay, D. Brown, J. Richards, R. Mumaw, Rev. H. Snyder, P. Hudlow, P. Sullivan, C. H. Smith, R. Rix, E. Burrows, W. Minear, B. Kennett, J. Moldenhauer, D. Hoxie, B. Lesko, S. Fidone, C. Wendler, R. Travis, J. Dill, R. W. Smith, S. Tuttle, T. Pazder, N. Rader, Jr., R. Leibrand, J. May, L. Buege, R. Bricmont, L. Rahbek, F. Matthies, B. Roshavin, R. Beggs, H. Engdahl, Jr., C. Albaugh, F. Grabas, Jr., C. Lukas, A. Solomon, J. LaVita, B. Bailey, E. Bendsen, T. Brown, C. Hammon, Rev. R. Navarre, H. Bishop, Mrs. J. Rains, H. Clevenger, J. Brower, R. Henderson, W. Whitton, W. McCutchen, J. Rustako, J. Harnwell, Mrs. J. Korman, J. Korman, R. Thorn, G. Lovi, D. Knecht, H. Torreyson, J. Knight, R. Breitengross, E. Reynolds, C. Humberd, J. Russell, C. Shurr, H. Suden, J. Carstens, T. Curran, D. Dreis, A. Van Buren, A. Daniels, L. Boatner, F. Clarke, R. Herrick, V. Schrader, R. Miller, A. Landis, T. Garan, A. Goldis.

The judges were about to adjourn when it was discovered that in order to engrave all of the above names on the barrel of the UNITRON Rotary Eyepiece Selector, it would be necessary



Octopi need not buy.

to increase the size of the gadget considerably. In its larger size it would hold not six, but approximately 89 eyepieces, and consequently most of the names based on "hex" and "sex" would no longer be appropriate. After much deliberation, the learned judges decided that, foolish though it may appear, they would go along with the original plan to select a **single** name and award a UNITRON Rotary Eyepiece Selector to the person (or persons) who had suggested it. The gravity of this decision so taxed their energies that they were unable to reflect further this month. If you're interested in the outcome, be sure to consult the May issue.

Orders Now Being Accepted

In addition to serving as chairman of the judging committee, the overworked Dodo has been busy as a bee booking orders for the new UNITRON Rotary Eyepiece Selector. We have concluded that while this accessory would not be essential for an octopus (who could hold one eyepiece in each of six tentacles, use one tentacle to focus, and have one left over to manipulate slow-motion controls), for ordinary observers there is a tremendous advantage in having 6 magnifications ready for instant use. To change powers, merely rotate a new eyepiece into position while the object stays centered and in focus in the field of view. If through inaccurate tracking you lose the object under observation, there is no need to resort to profanity — merely rotate the wide-field 40-mm. eyepiece into position and convert the telescope into a giant viewfinder.

The modest price of this invaluable aid to observing is only $24.75 postpaid, complete in an attractive cabinet. As you hunt in your overcoat pocket for your checkbook, chances are that you will come across that missing eyepiece, all scratched from contact with keys and coins. This certainly proves that you need the Selector, so we'll look forward to receiving your order in a day or so.

On checking our files, we are rather disturbed to find that we have never received a request for our catalog from an astronomer in Tierra del Fuego. To encourage such an inquiry, the first to inquire from that location will receive one of the Selectors free of charge. All others who write will receive free of charge our informative literature which is guaranteed to be worth the slight effort involved in writing for it. For a real rush reply, mention the Dodo.

See pages 250 and 255.

United Scientific Co.
204-206 MILK STREET
BOSTON 9, MASS.